The AMSAT Journal

Incorporating the AMSAT Newsletter
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Editor: ***Joe Kasser, G3ZCZ***
Managing Editor: ***Robert M. Myers, W1XT***

The Orbital Decay of AMSAT-OSCAR 13?

By Karl Meinzer, DJ4ZC
AMSAT-DL

Information has recently been circulated expressing concern about the decay of the orbit of the AMSAT-OSCAR 13 spacecraft between 1992 and 1997.

Elliptic orbits with high inclination (like AMSAT-OSCAR 13) are potentially unstable due to luni-solar pertubations. This phenomenon has been known for a long time and in fact some Molniya satellites have prematurely decayed due to this mechanism. AMSAT was aware of this situation and had a study performed in the late 1970's for the Phase 3 program by a NASA expert. The conclusion of the study was, that the height of the perigee can oscillate with an amplitude of +/-1000 km. As a consequence the minimum perigee height for the Phase 3 satellites was chosen to be 1500 km. On AMSAT-OSCAR 13, 2500 km were chosen to provide an additional margin against decay.

Recently, the problem of orbit stability was revisited by Victor Kudielka, OE1VKW (*AMSAT-DL Journal* 2, 90, pp. 5-7). OE1VKW discovered that the pertubations can have a longer "time-constant" and thus result in much larger effects than previously believed. In particular he predicted a possible decay of AMSAT-OSCAR 13 in early 1997. At this time we do not understand the discrepancy between the old study and OE1VKW's results. Since OE1VKW's results so far are in good agreement with the actual orbit of AMSAT-OSCAR 13, there is little doubt that his computations are basically correct. So the conclusion is inevitable that the old study was either too coarse or that the change of the lunar orbit (18.6 years nutation period, 8.6 years period of perigee rotation) has invalidated the original study.

The publication of OE1VKW's work triggered a flurry of activity in the USA. In particular Bob McGwier, N4HY, used a NORAD tracking program and found that the decay may happen as early as 1992. Bob states that he used the program as a black box without having user instructions. Unfortunately, the orbit situation is such that some very slight parameter-changes have a dramatic influence on the lifetime. Also, numerical integration programmes have many potential pitfalls. So at this time, we can only conclude that the perigee height of AMSAT-OSCAR 13 is coming down and this may lead to the loss of AMSAT-OSCAR 13 during the nineties.

With the orbit of AMSAT-OSCAR 13, we aparently were very lucky and very unlucky at the same time. We were lucky in that we used our excess propulsion capability to increase the perigee height over the original figure just to "buy margin" without a strong reason for doing so. We were also unlucky, because the present studies were not available in 1988. It would have been easy to either wait after the first motor-burn for a sufficient RAAN-change before the final burn thus eliminating the problem or to increase the perigee height even further. Certainly we will not be so blue-eyed with Phase 3-D.

It is unclear at this time, in what direction the orbit will be influenced by the onset of airdrag. It could either make the orbit more stable or accelerate the decay. Also it will be worthwhile to investigate if we have any means to prolong the life of AMSAT-OSCAR 13 by exploiting the onboard systems. Of course, AMSAT-DL will make every effort to keep AMSAT-OSCAR 13 in operation as long as possible. We hope that we can keep AMSAT-OSCAR 13 operational until Phase 3D is launched to give us continuity.

Beginning on page 16 are Election statements about the AMSAT Board of Director candidates now up for election. Your ballot is inserted into this issue of *The AMSAT Journal*. Please remove the ballot card from the binding and follow the directions to cast your vote. Please return it to AMSAT Headquarters as soon as possible, and in no case to arrive any later than September 15, 1990.

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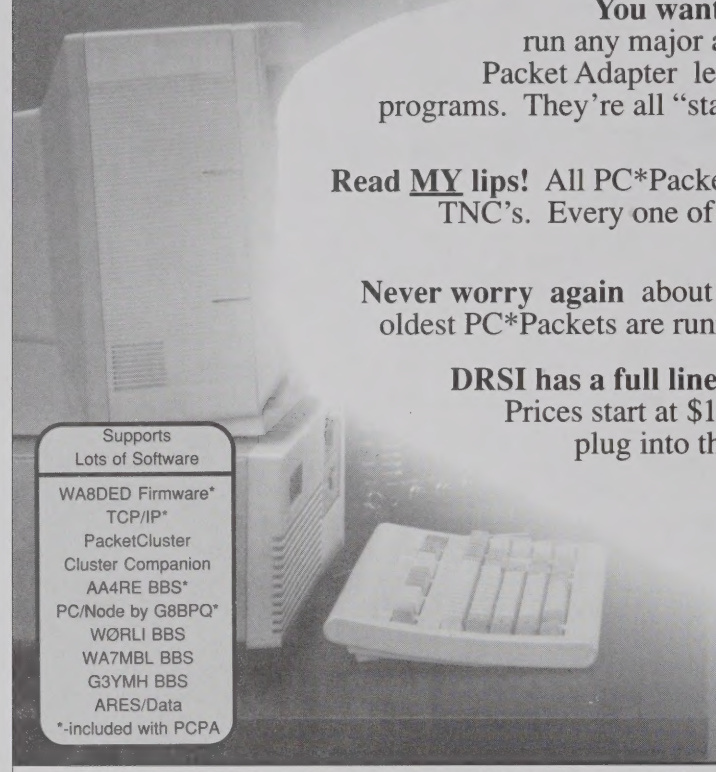

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Off the Pad:

A Proposed Standard for Packetized Telemetry

By Joe Kasser W3/G3ZCZ

Introduction

I've received a few letters and comments about my column on telemetry in the August 1989 issue of the *AMSAT Journal*. The way things go, that constitutes an overwhelming response. This is the first of two columns on converting telemetry into our greatest asset.

There are currently five operational satellites sending back packetized telemetry. Packetized telemetry has the

(Continued on page 15)

Lindenblad Antennas for Microsat Omnidirectional Reception

By Howard Sodja, W6SHP @ WD6CMU
4317 Santa Rita Rd
El Sobrante, CA 94803

Signs of wear were becoming evident in my satellite antenna arrays after several months of using them to track the MicroSats. My elevation rotor controller was starting to malfunction and my 9913 coax was developing permanent kinks at the point where it flexes leaving my beams. This means that coax failure is not far away. This state of affairs reminded me of the warnings that I had heard about the potential need for high antenna maintenance in daily MicroSat use. The desire for something better motivated me to experiment with omnidirectional MicroSat antennas. My first try was with a simple 70cm ground plane, but the results were disappointing. Print was not 100% until the birds were 10 degrees above the horizon, and even then, deep fades when the birds were high left me with several periods of no printing on every pass. J-pole and Discone antenna users I spoke with also reported deep fade problems.

As I always change polarization on my satellite beams to keep the downlink signal strength up, I reasoned that the solution would be to use a pair of switchable left and right circular polarized omnidirectional antennas. In searching the amateur antenna literature the only circular polarized omnidirectional antenna I found was the Lindenblad antenna described in the Satellite *Experiment's Handbook*[1] Ease of construction and tuning made this antenna the natural choice.

As can be seen in Figures 1 and 2 (A) the Lindenblad antenna consists of four half wave folded dipoles slanted 30 degrees to the horizon, oriented 90 degrees to each other in azimuth, spaced 0.3 wavelength apart. They are tied together with four sections of half wave length 300 ohm twin lead that brings the impedance of the four 300 ohm folded dipoles down to a common 75 ohms point. A quarter wave section of 93 ohm RG62A/U transforms this 75 ohm point to 50 ohms as shown in Figure 3. Since the polarization of the antenna is fixed, I had to build a pair of them and use a remote coax

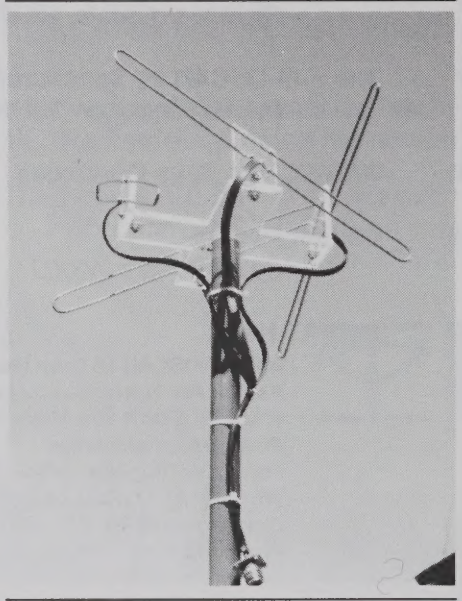


Figure 1

switch to select either the RHCP (Right Hand Circular Polarized) or LHCP (Left Hand Circular Polarized) antenna. The output from the switch then goes to a GaAsFET preamp. This arrangement delivers a signal that gives me solid copy from 5 degrees above the horizon, as long as I change antennas (polarization) during deep fades.

I now get solid print when my FT726R's S meter indicates at least 1.5 (my noise floor is S1). Whenever the S meter goes down to S 2 or 3 I switch antennas (polarization). This will always bring the signal back up as much as 6 S units as long as the birds are above 5 degrees. I have found that I always need to switch near the horizon and when the birds are near overhead. If I do not hear a bird at AOS time, changing polarization brings it out of the noise. Generally RHCP is best for WEBER-OSCAR 18 and LUSAT-OSCAR 19 at AOS, while LHCP is best for AMSAT-OSCAR 16. I average 5 to 7 polarization changes per pass.

An unexpected benefit with the Lindenblad antenna is the reduction of computer noise. My ground plane picked up a couple of computer birdies that would capture my TAPR modem's frequency stepper when the MicroSat's signals faded. Now these birdies are barely audible and are too weak to capture the TAPR's frequency stepper.

Figure 2 (B) shows the free space vertical power vs. elevation angle for the Lindenblad antenna. This works out great for the MicroSats. I often get intermittent print below 5 degrees. As the birds get higher, they also get closer and stronger. This results in a signal that only gets better as the birds climb higher.

An interesting observation, for which I have no explanation, is that although I can get solid print at S 1.5 with the Lindenblad (with a S 1 noise floor), I found that with my 70cm ground plane I'd have holes in my copy until almost S 3. Perhaps the circular polarization detects the signal's phase shift better near the noise floor. Anyone know of a theoretical explanation for this observation?

Construction

Figure 2 (A) and 3 show a schematic (that is not to scale) of the Lindenblad's layout. Table 1 contains the dimensions for Lindenblad antennas cut for 436 MHz. Rather than use wood as suggested in the Satellite Experimenter's Handbook, I used some scrap quarter inch thick plexiglass that I had left over from another antenna project. Check your Yellow Pages for plastic firms and you may be as fortunate as I was, and be able to get their scraps cheap or free. But wood or any other nonconducting material should work fine.

As getting organized and moving on a project is often the most time consuming part, I recommend building both the RHCP and LHCP antennas at the same time. You will find everything you do on the second antenna will take a fraction of the time it did

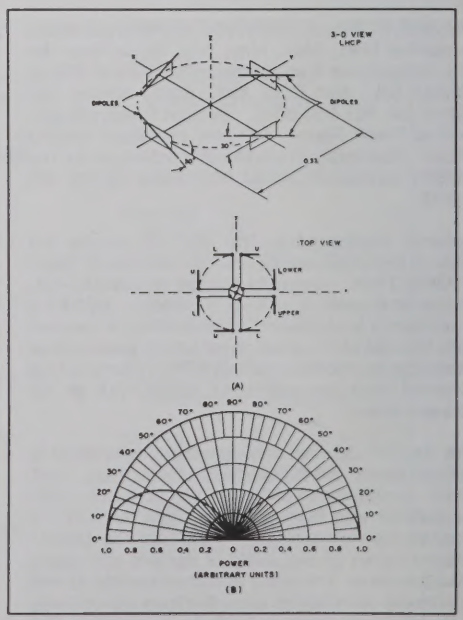


Figure 2 — From the *Satellite Experimenter's Handbook*. 2A not to scale.

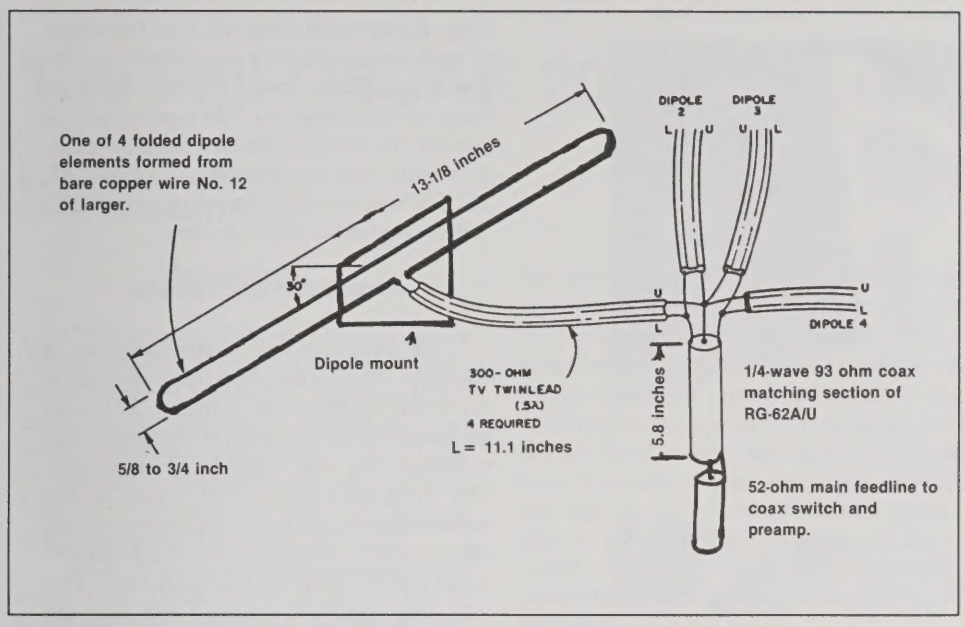

One of 4 folded dipole elements formed from bare copper wire No. 12 of larger.
13-1/8 inches
30°
Dipole mount
5/8 to 3/4 inch
300- OHM TV TWINLEAD (.5λ) 4 REQUIRED
L = 11.1 inches
5.8 inches
DIPOLE 2
DIPOLE 3
DIPOLE 4
1/4-wave 93 ohm coax matching section of RG-62A/U
52-ohm main feedline to coax switch and preamp.

Figure 3 — From the *Satellite Experimenter's Handbook*, modified for 70 cm and antenna described in article. Not to scale.

on the first one. And, in my case the second one was built better. Practice makes perfect.

Figure 4 shows how I laid out the two 8 1/8 inch square plexiglass bases and dipole mounts to be cut. First drill each corner with a 1/4 inch drill. This eliminates the stress points at the sharp corners from which cracks will eventually propagate in plastics. Then cutting into the sides of these holes will give you nice rounded corners. Do not try to cut plexiglass with a saber saw unless you can slow the blade speed way down. I was quite surprised to find my first plexiglass cut melted back together after the hot blade passed through. I still had one piece of Plexiglass when I was done! Either take your time with a hacksaw or (as I did after a couple slow hacksaw cuts) seek out a friend with a band saw and adjust the pulleys to its slowest speed.

The dipole mounts are then cut 30 degrees on top and mounted to the base with a small angle bracket using brass hardware. I found an old extruded aluminum shape that I cut into brackets 1/2 inch square on each side. Right angle extruded aluminum stock can be found in hardware stores. You could also glue or screw the dipole mounts to the base if your materials permit.

Be sure the dipole mounts slope the same way on each base, and opposite from the other base. The polarization will be RHCP (clockwise) or LHCP (counterclockwise) from the perspective of viewing the 30 degree slopes from the center of the base. Figures 1 and 2 (A) are LHCP.

Because of the high frequency of these antennas, measurements of the antennas and transmission line matching sections must be as exact as you can possibly make them. You cannot trim or add to a folded dipole as you can with a straight dipole element. I recommend using a jig consisting of two dowels (or other round object) mounted to a board or workbench. The

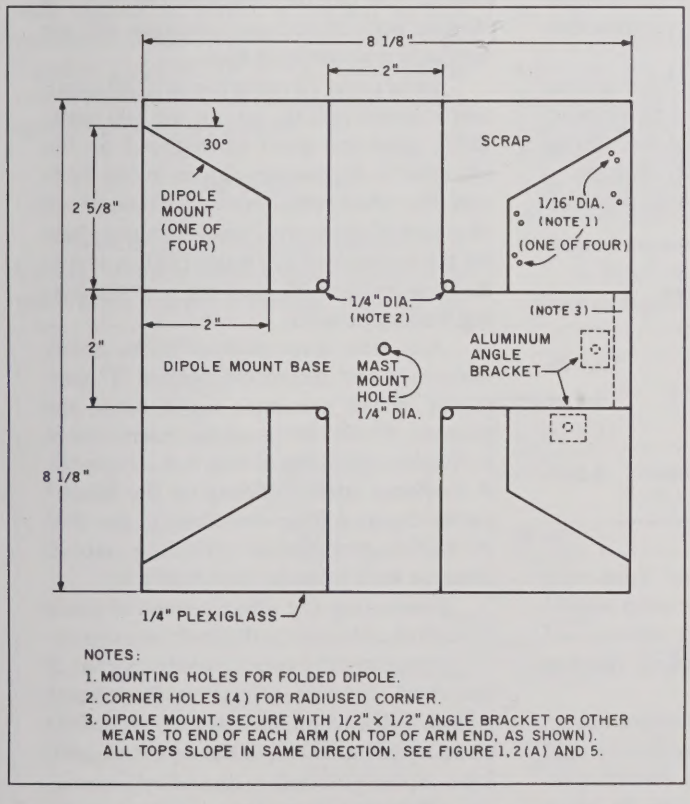
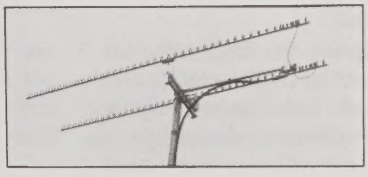

8 1/8"
2"
30°
SCRAP
2 5/8"
DIPOLE MOUNT (ONE OF FOUR)
1/16" DIA. (NOTE 1) (ONE OF FOUR)
1/4" DIA. (NOTE 2)
(NOTE 3)
2"
2"
DIPOLE MOUNT BASE
MAST MOUNT HOLE 1/4" DIA.
ALUMINUM ANGLE BRACKET
8 1/8"
1/4" PLEXIGLASS
NOTES:
1. MOUNTING HOLES FOR FOLDED DIPOLE.
2. CORNER HOLES (4) FOR RADIUSED CORNER.
3. DIPOLE MOUNT. SECURE WITH 1/2" x 1/2" ANGLE BRACKET OR OTHER MEANS TO END OF EACH ARM (ON TOP OF ARM END, AS SHOWN). ALL TOPS SLOPE IN SAME DIRECTION. SEE FIGURE 1, 2 (A) AND 5.

Figure 4 — Layout of cuts made on 1/4-inch Plexiglass 8-1/8 x 8-1/8 inches square. Drill four 1/4-inch dia. corner radius holes first. Then cut to side of holes. 1/16-inch dia. folded dipole mounting holes are drilled to fit folded dipoles after dipole mounts are made. Loop No. 20 bus wire around folded dipole and through mounting holes and twist tight on other side to secure. See Figure 5 on next page.

DOWN EAST MICROWAVE



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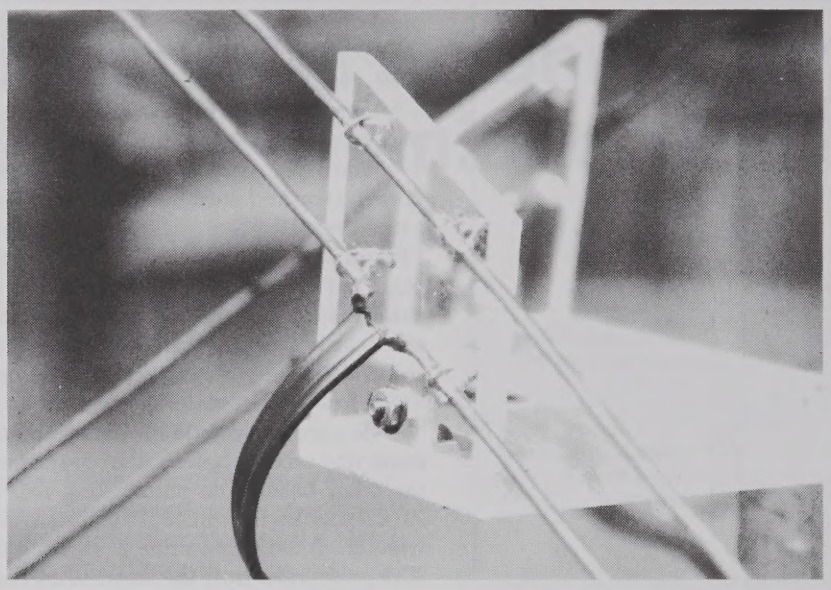


Figure 5.

extra time making a jig will pay for itself when you make your 8 folded dipoles. I used number 12 bare copper wire because I had it on hand, but if I needed to buy the wire I would have gotten number 10 or 8 wire for the extra rigidity. I found the resonant frequency for the folded dipoles was the same with the outside dimensions of the "fold" between 5/8 and 3/4 inch. A half inch gap at the bottom of the folded dipoles was sized to fit the width of the connecting twin lead.

The folded dipoles are easily attached to the dipole mounts by drilling four pairs of 1/16 inch diameter holes on each dipole mount to match the element's desired position. Secure the dipole with bus wire (I used # 20) looped over the elements and through these holes. Twist the wire on the other side to tighten the loop to secure the element to the dipole mount. Then a touch of solder secures the bus wire to the dipole on one side, and makes the wire twist on the other side permanent. See figure 4.

The dimensions of the power divider and phasing twin lead lines are calculated for ordinary TV twin lead with a 0.82 velocity factor. Likewise the quarter wave coax matching section was figured for RG62A/U with a 0.86 velocity factor. If you use transmission lines with different velocity factors adjust these lengths with the formula:

$$\text{1/2 wavelength} = \frac{5905 \times \text{velocity factor}}{436 \text{ MHz}}$$

I cannot overemphasize the importance of precise measurements of length. The measurements are of the wire in the dielectric. Make all your connections using the wire or shield stripped of dielectric as short as mechanically possible, and beware of the twin dangers of overheating (melting the dielectric) and cold solder joints. Be sure to buy extra twinlead and coax so you can throw away any sections that you are not completely happy with, and try again until you get it perfect. I don't think it is possible to make a perfect 70 cm quarter wave coax matching section without trashing at least one (again, practice makes perfect).

To keep moisture out of the quarter wave coax matching sections I rolled small pieces of COAX-SEAL™ (sold for sealing coax connectors) into gummy threads. I then wrapped them around both coax ends and exiting wires and molded them with my fingers to form a nice neat solid weatherproof seal. Beware of using silicone as I can testify to the corrosive effects this has on coax shields.

TABLE 1 — Lindenblad Antenna Dimensions at 436 MHz

Folded dipole length:	13.1 in.
0.3 wavelength spacing:	8.1 in.
Twinlead half wave match:	11.1 in.
93-ohm coax quarter wave match:	5.8 in.

I urge that you use "N" connectors on the best low loss 50 ohm coax you can get between your antenna, coax switch, preamp and receiver. The loose fit some complain about when using "N" connectors on 9913 coax can be easily remedied by wrapping 3 1/2 to 4 inches of plastic electrical tape around the end of the coax up against the "N" connector's shield clamp ring. Experiment until you find the length of tape that provides a snug slip fit for the clamp nut when it screws into the main body of the connector. Be sure to get the special "N" connectors that have the oversize center pin (such as the Amphenol 82-202-1006) so you don't have to file the 9913's center conductor down to size.

Installation and Results

My desire to test these antennas as soon as I finished building them resulted in my screwing them to a couple of old broom sticks and fastening them with pipe clamps to joists in my attic spaced eight feet apart. The extra time and effort I took in my measurements and matching networks paid off as the SWR was 1.05 to 1 at 435 MHz and 1.1 to 1 at 437 MHz for both antennas! This was with the SWR sensor 3 feet from the antennas. Their performance, discussed at the start of this article, was so good I decided to keep them there away from the ravages of the weather and large (feathered) birds.

This project is a bit more complex than other omnidirectional antennas for MicroSat use, but it is much easier and cheaper than a standard tower mounted circular polarized azimuth and elevation rotating beams. The pair definitely outperform the simpler omnidirectional antennas and are virtually maintenance free.

Tests using 10 watts to my 10 dB gain 2 meter beam uplink, giving me 100 watts EIRP, gave me good throughput on the MicroSat's digipeaters down to the horizon. But when I tried running 100 watts out of my amplifier to my 2 meter ground plane for the equivalent 100 watts EIRP, a severe desense problem blocked my receiver during transmit bursts.

A quarter wave stub cut to the uplink frequency and connected with a "T" connector to my preamp's input cured the desense. However the added insertion loss to the downlink signal was not acceptable. A weekend spent building up the Mode J cavity desense filter described in the 1980 *ARRL Handbook* paid off by ridding me of all desense with minimal insertion loss.

Evaluating the effectiveness of mode JD uplink antennas is difficult because of 1) not hearing your downlink signal, 2) the short duration of passes, 3) unheard uplink QRM when several stations collide on an uplink channel, 4) the reported problems of phase distortion caused by geomagnetic disturbances on 2 meters which do not effect 70 cm,[4] and, 5) other variables unique to each satellite and QTH.

My limited experimentation using a 100 Watts feeding a simple 2 meter ground

(Continued on page 30)

The Fuji-OSCAR 20 Spacecraft

By Joe Kasser W3/G3ZCZ
Editor, The AMSAT Journal

Introduction

On February 7 1990, the National Space Development Agency of Japan (NASDA) put the Marine Observation Satellite (MOS) 1b into orbit. The launch vehicle also carried two secondary payloads, Fuji-OSCAR 20 and the Deployable Boom and Umbrella Test (DEBUT) spacecraft which is similar in shape and weight to Fuji-OSCAR 20.

MOS-1b was placed into a circular polar orbit, then DEBUT and Fuji-OSCAR 20 separated from the launch vehicle at 0233, above Santiago, Chile. First signals from the spacecraft were received in Tokyo around 0309 UTC.

Fuji-OSCAR 20 is similar in construction to Fuji-OSCAR 12. In fact, it was originally constructed as a backup to Fuji-OSCAR 12 and designated as JAS-1B. It has since been modified and improved as a result of the lessons learned during the flight of Fuji-OSCAR 12. Fuji-OSCAR 12 was known as Fuji-1 in Japan, so this spacecraft is known by the Japanese as Fuji-2 and as Fuji-OSCAR 20 (or FO-20) by the rest of the world. This article, describes the spacecraft and its mission.

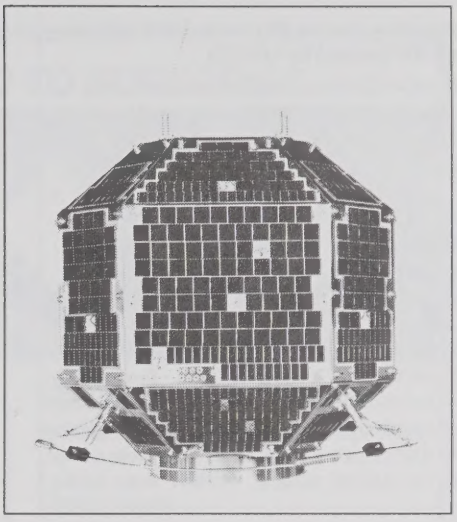
The Orbit

Fuji-OSCAR 20's planned service life is 5 years. It is in a sunsynchronous elliptical polar orbit, having a perigee of about 900 km and an apogee of about 1740 km at an inclination of 99 degrees. The Period of the orbit is about 105 minutes. In this orbit, the spacecraft passes over a given line of latitude at approximately the same time each day. In this orbit, the spacecraft is shielded from the sun by the earth for about 33% of the time. This eclipse means that the solar cells can only provide power for about 70 minutes in each orbit and that the on-board nickel cadmium storage batteries have to power the spacecraft for the remaining 35 minutes.

The Spacecraft

Fuji-OSCAR 20 weighs about 50 kg. and is a polyhedron shaped spacecraft 440mm in diameter and 470mm in height covered by approximately 1500 gallium arsenide solar cells which provide about 11 Watts of power to keep the 11 series-connected NiCad cells (rectangular) with a capacity of 6 AH charged. There are 26 sides to the polyhedron which almost makes it spherical for all practical purposes other than sticking solar cells to it. Fuji-OSCAR 12 was the same shape but only carried about 600 cells. This larger number of cells means that Fuji-OSCAR 20 has a positive power budget and should not need to be switched off to recharge.

A block diagram of the spacecraft is shown in Figure 1. The Power supply converts the raw bus voltage of +11 to +18 V (+14 V average) to the three regulated voltages (+10 V, +5 V, -5 V) used by the rest of the satellite with an efficiency greater than 70%.



Fuji-OSCAR 20

The attitude of the satellite is maintained by using the torque generated by the interaction of two permanent magnets with the earth's magnetic field. This is a fairly conventional technique used in the OSCAR series. Temperature stability is achieved by using thermal insulation.

The Payload

Fuji-OSCAR 20 carries two Mode J transponders, both of which may be operational at the same time. One transponder is analog (Mode JA), the other is digital (Mode JD).

The frequencies and capabilities of the analog transponder are similar to those of Fuji-OSCAR 12. It consists of an inverted hetrodyne linear translator with a passband 100 kHz wide, operating with a mode J Uplink passband of 145.9 to 146.00 MHz, and a corresponding Downlink Passband of 435.9 to 435.8 MHz. The spacecraft has a Transmitter Output of approximately 1 watt. A ground station needs an Uplink EIRP of about 100 W to communicate through the transponder. The JA telemetry beacon is on the nominal frequency of 435.795 MHz with a power output of about 100 mW and can use CW or PSK modulation. Fuji-OSCAR 20 is using the callsign 8J1JBS and the beacons transmit telemetry in the same manner as Fuji-OSCAR 12.

The digital transponder provides store-and-forward packet communication using the AX.25 link level protocol, version 2. Stations who used Fuji-OSCAR 12 are able to use Fuji-OSCAR 20 without making any modifications to their equipment. The uplink requires Bi-phased Manchester code

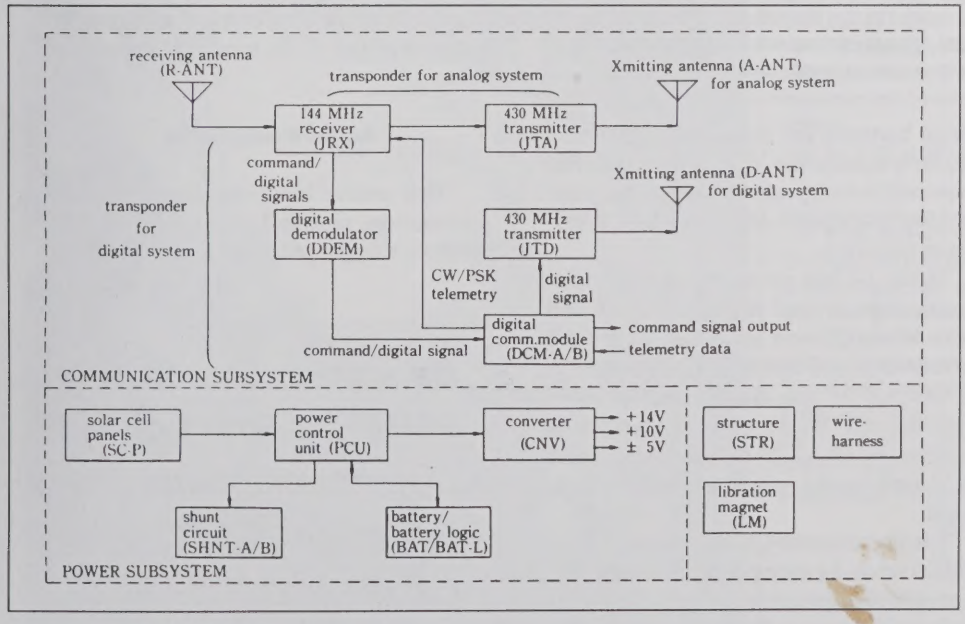


Figure 2 — Block diagram of JAS-1B

Figure 2 — Typical Message Listing from the BBS (copied by KI6QE)

Fuji-OSCAR 20/JAS1b Mailbox ver. 2.00
commands [B/F/H/M/R/U/W]
Use H command for Help
JAS>

No.	Date	UTC	From	To	Subject
0086	04/13	05:15	WB6GFJ	W6SHP	Welcome
0085	04/13	05:14	WB6LLO	KI6QE	Software
0084	04/13	05:14	WB6GFJ	W9FMW	Our Chat
0082	04/13	03:38	W9FMW	WA4EJR	Message on CIS
0080	04/13	03:36	KG6EX	N1GCR	From Ashley
0078	04/13	03:32	KG6EX	KD8SI	From Ashley
0077	04/13	03:31	KG6EX	N8AM	From Ashley
0076	04/13	03:30	KG6EX	DD4YR	From Ashley
0075	04/13	03:27	KG6EX	DL1CR	From Ashley
0074	04/13	03:25	KG6EX	G3RUH	From Ashley

on an FM signal, at a bit rate of 1200 bps. There are 4 Uplink Frequencies: 145.85 MHz, 145.87 MHz, 145.89 MHz, 145.91 MHz. The necessary ground station Uplink EIRP is also about 100 W. The transponder has an output power of about 1 W on a downlink frequency of 435.91 MHz and uses NRZI PSK at 1200 bps. The same PSK modem used to copy Fuji-OSCAR 12 or the MicroSats is needed to copy Fuji-OSCAR 20. The downlink channel also carries packet telemetry.

The 144 MHz receiving antenna is a ring turnstile mounted at the bottom of the side panels. The 435 MHz transmitting antenna is a turnstile antenna mounted at the top of satellite. Both antennas are circularly polarized. Ground tests have shown that the transmitting antenna is more omnidirectional than that of Fuji-OSCAR 12, however due to the structure of the hybrid circuitry which allow both transponders to share the same antenna, the sense of the circular polarization on the downlink is different for each mode. As the apparent polarization is different depending on the geometry between the spacecraft and the groundstation, you will probably have to change between left hand and right hand circular polarization during a pass. The spacecraft is designed so that you can usually keep the uplink and downlink polarization the same.

Table 1 — First European MODE-JD Self-Contact via FUJI OSCAR-20 made!

Telemetry and Self-Connect:

fm 8J1JBS to BEACON ctl UI^ pid F0
JAS1b RA 90/02/14 11:23:30
551 427 695 699 741 837 841 821 474 638
617 001 507 517 531 527 533 532 654 000
681 665 661 686 999 643 874 438 046 000
110 111 000 000 100 000 001 111 111 000

fm DB2OS to DB2OS ctl RR1-

fm DB2OS to DB2OS ctl I11^ pid F0
DB2OS de DB2OS (14.2.1990 um 11:15 utc)

fm DB2OS to DB2OS ctl I12^ pid F0
1st QSO via FUJI OSCAR-20

fm DB2OS to DB2OS ctl RR3v

fm 8J1JBS to BEACON ctl UI^ pid F0
JAS1b M0 90/02/14 11:26:00
Repeater is at your service from90/02/12 03:05:00
The JD Transmitter is available in all orbits during JD mode.

Figure 3 — Fuji-OSCAR 20 PSK telemetry (as copied by KI6QE)

03-Apr-90 17:40:32 8J1JBS*>BEACON:
JAS1b RA 90/04/03 17:45:18
554 433 700 686 757 837 841 823 398 666
617 001 503 516 526 523 526 523 654 000
683 675 685 684 999 643 875 316 002 000
110 111 000 000 100 000 001 011 111 000
03-Apr-90 17:40:34 8J1JBS*>BEACON:
JAS1b RA 90/04/03 17:45:20
566 427 699 705 746 837 841 824 541 659
617 001 503 516 526 523 526 523 654 000
683 675 686 683 999 642 874 316 002 000
110 111 000 000 100 000 001 011 111 000
03-Apr-90 17:40:36 8J1JBS*>BEACON:
JAS1b RA 90/04/03 17:45:22
573 427 699 705 757 828 841 823 478 664
617 001 503 516 526 523 526 523 654 000
683 675 686 683 999 643 875 316 002 000
110 111 000 000 100 000 001 011 111 000
03-Apr-90 17:40:38 8J1JBS*>BEACON:
JAS1b RA 90/04/03 17:45:24
602 406 700 706 758 838 841 823 489 678
617 001 503 516 526 523 526 523 654 000
683 675 686 683 999 643 874 316 002 000
110 111 000 000 100 000 001 011 111 000
03-Apr-90 17:40:40 8J1JBS*>BEACON:
JAS1b RA 90/04/03 17:45:26
595 416 700 705 758 837 841 821 442 665
617 001 503 516 526 523 526 523 654 000
683 674 687 682 999 643 875 316 002 000
110 111 000 000 100 000 001 011 111 000
03-Apr-90 17:40:42 8J1JBS*>BEACON:
JAS1b RA 90/04/03 17:45:28
629 393 701 707 760 837 840 823 376 671
617 001 503 516 526 523 526 523 654 000
682 675 686 683 999 643 874 316 002 000
110 111 000 000 100 000 001 011 111 000

Mode JA has provided strong trans-Atlantic signals and many CW and SSB QSOs. Mode-JD was switched on for the first time during Orbit #95. To Digipeat via Fuji-OSCAR 20 you don't need to use a digipeater call. With the present version of the software, all AX.25 frames with a valid CRC heard by the spacecraft will be digipeated.

The first claimed QSO on mode JD is by DBØOS when he connected to himself and an extract from the information he copied at that time is shown in Table 1.

The spacecraft also carries a BBS which is accessed by means of the same commands used to access a terrestrial WA7MBL/WØRLI/AA4RE type of BBS. You access the BBS by connecting to 8J1JBS on any of the four uplink channels. When you do connect to it, make sure that you disconnect before LOS because Fuji-OSCAR 20 only allows 16 simultanious connections. Stations that hang in there after the satellite drops below their local horizon block access by other stations and have been christened 'Zombies'. The BBS program is a modified version of the BBS program written for Fuji-OSCAR 12 and allows the use of 4 banks (1Mbyte) of memory. A typical list of messages copied by KI6QE is shown in Figure 2.

The Telemetry

The spacecraft telemetry is transmitted either as CW or as PSK. The CW telemetry monitors 12 analog data points and 33 status points, the PSK telemetry monitors 29 analog data points and 33 status points. A typical set of PSK telemetry packets captured by KI6QE is shown in Figure 3. The telemetry decoding equations used are different to those used on the MicroSats and will be published when they become available.

Summary

This article has been an introduction to Fuji-OSCAR 20, a friendly little bird which provides strong mode J signals both for analog and digital communications as well as telemetry which can be used for educational purposes. If you can work mode B then you ought to be able to work mode J with just a little more effort. Tune in one evening and say 'Kon bon wa' as it goes by. Remember the 'J' in mode 'J' stands for Japan.

Acknowledgments

This article has been compiled from information received from AMSAT-UK, DBØOS, KI6QL, JAMSAT and the JARRL.

Be sure to vote in AMSAT's Board of Director elections. See page 16 for the details.

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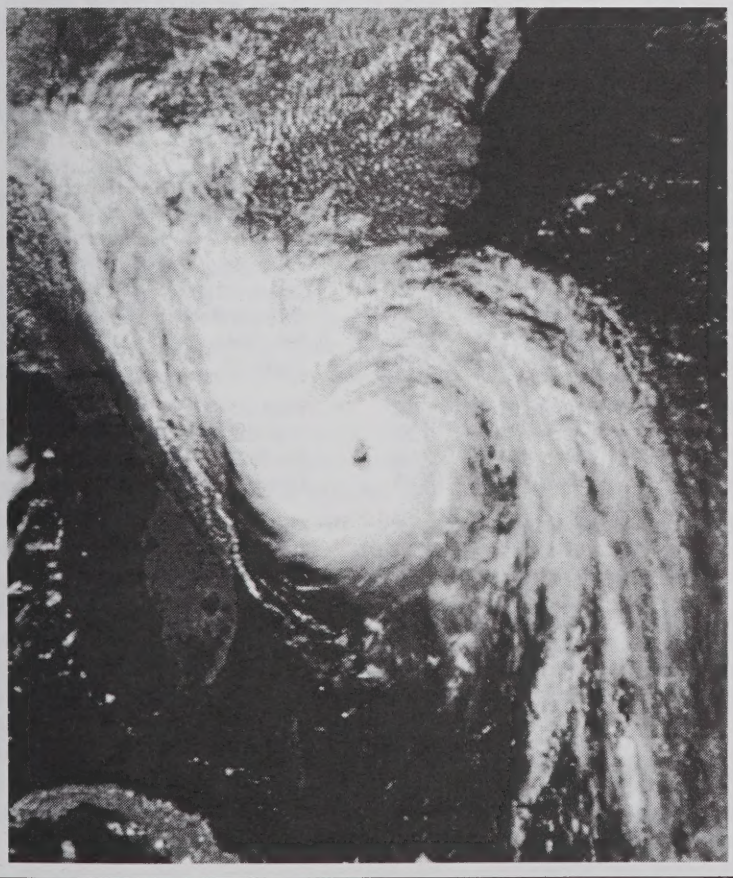

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SAREX
The Saga Continues

The delay in the launch of the Space Shuttle Columbia (STS-35) carrying the Shuttle Amateur Radio Experiment (SAREX) mission, allows this issue of the Journal to bring you more information about the Robot.

SAREX Call Sign Clarification

The articles published in *The AMSAT JOURNAL* and *73 MAGAZINE* indicated that the SAREX Robot would use the call WA4SIR-1 (i.e. using a SSID = 1), and in more recent SAREX @ AMSAT packet bulletins it was indicated that the call would be just WA4SIR (i.e. SSID = 0). Several people sent messages indicating that they were confused. Both the HK21 Robot TNC and the operational software for the GRID lap top computer have the calls defaulted to WA4SIR (SSID = 0) and that call should be used unless, for some unanticipated reason, the defaults are over-ridden.

The best advice is for you to MONITOR the downlink signals from STS-35 and try to connect to whatever call you see on the downlink. The Robot TNC code uses only one SSID at a time. *Tom, W3IWI*

STS-35 Operations Time line

This table details planned events for Ron Parise, WA4SIR's SAREX activities on the STS-35 mission of the Shuttle Columbia. The tabular entries are given in both Mission Elapsed Time (MET) and UTC (GMT) time. As the launch is delayed from May 30th at 04:38Z, all UTC times should be adjusted accordingly when the new date is announced, and yet another time if lift-off is delayed again. All times are approximate and should only be used for guidance.

In general Ron's voice opportunities for scheduled demonstrations all take place during the pre-sleep and post-sleep periods. The planned classroom demonstrations to be relayed via Australia and Brazil are denoted by the (VK) and (PY) windows. Any time Ron might choose to try general voice operation should also be during the pre- and post-sleep windows. Ron must also eat and take care of personal matters during these pre- and post-sleep periods.

SAREX Robot packet operations are planned for the approximately 12 hour windows between the post- and pre-sleep while Ron is on duty with the ASTRO experiments.

Table 1 shows the mission time line for the 30 May launch date. When the new date is announced, overlay the new days and times based on the MET on the table to see what will happen when.

Check your local packet BBS for bulletins addressed to SAREX @ AMSAT and listen to WA3NAN, W5RRR and W6VIO for updates during the mission.

Tom, W3IWI

The SAREX Frequencies

Tom Clark, W3IWI, in a note circulated via packet radio suggested that it would be prudent for folks in areas where local activity was on either the 144.95 MHz SAREX

Table 1 — MISSION ELAPSED TIME UTC

DAY FROM DAY -TO- #HH:MM #HH:MM	UTC FROM TO- DATE HH:MM HH:MM	ACTIVITY
0d+00:00	30-May 04:38	Nominal Launch
0d+10:30 - 0d+11:00	30-May 15:08 - 15:38	Pre-Sleep, no activity
0d+19:00 - 0d+21:45	30-May 23:38 - 02:23	Post-Sleep
0d+19:00 - 0d+20:40	30-May 23:38 - 01:18	Setup SAREX
0d+20:25 - 0d+20:40	31-May 01:03 - 01:18	Demo #0 (VK)
0d+20:45 - 1d+10:20	31-May 01:23 - 14:58	SAREX Robot
1d+10:20 - 1d+12:00	31-May 14:58 - 16:38	Pre-Sleep
1d+10:20 - 1d+10:30	31-May 14:58 - 15:08	Demo #1 (PY)
1d+20:22 - 1d+21:15	01-Jun 01:00 - 01:53	Post-Sleep
1d+21:15 - 2d+09:00	01-Jun 01:53 - 13:38	SAREX Robot
2d+08:35 - 2d+10:30	01-Jun 13:13 - 15:08	Pre-Sleep
2d+09:10 - 2d+09:25	01-Jun 13:48 - 14:03	Demo #2 (PY)
2d+18:30 - 2d+20:00	01-Jun 23:08 - 00:38	Post-Sleep
2d+19:40 - 2d+20:00	02-Jun 00:18 - 00:38	Demo #3 (VK)
2d+20:00 - 3d+07:55	02-Jun 00:38 - 12:33	SAREX Robot
3d+07:52 - 3d+09:30	02-Jun 12:30 - 14:08	Pre-Sleep
3d+08:00 - 3d+08:10	02-Jun 12:38 - 12:48	Demo #4 (PY)
3d+17:30 - 3d+19:00	02-Jun 22:08 - 23:38	Post-Sleep
3d+18:30 - 3d+18:50	02-Jun 23:08 - 23:28	Demo #5 (VK)
3d+19:00 - 4d+06:55	02-Jun 14:38 - 11:33	SAREX Robot
4d+06:40 - 4d+08:30	03-Jun 11:18 - 13:08	Pre-Sleep
4d+08:25 - 4d+08:40	03-Jun 13:03 - 13:18	Demo #6 (PY)
4d+16:30 - 4d+18:15	03-Jun 21:08 - 22:53	Post-Sleep
4d+17:15 - 4d+17:35	03-Jun 21:53 - 22:13	Demo #7 (VK)
4d+18:00 - 5d+06:00	03-Jun 22:38 - 10:38	SAREX Robot
5d+05:45 - 5d+08:00	04-Jun 10:23 - 12:38	Pre-Sleep
5d+07:20 - 5d+07:30	04-Jun 11:58 - 12:08	Demo #1 (PY)
5d+17:00 - 5d+17:20	04-Jun 21:38 - 21:58	Post-Sleep
5d+17:20 - 6d+06:00	04-Jun 21:58 - 10:38	SAREX Robot
6d+05:45 - 6d+08:00	05-Jun 10:23 - 12:38	Pre-Sleep
6d+07:40 - 6d+07:55	05-Jun 12:18 - 12:33	Demo #8 (PY)
6d+16:00 - 6d+16:37	05-Jun 20:38 - 21:15	Post-Sleep
6d+16:30 - 7d+06:05	05-Jun 21:08 - 10:43	SAREX Robot
7d+06:00 - 7d+07:00	06-Jun 10:38 - 11:38	Pre-Sleep
7d+15:00 - 7d+17:50	06-Jun 19:38 - 22:28	Post-Sleep
7d+15:20 - 7d+15:40	06-Jun 19:58 - 20:18	Demo #9 (VK)
7d+17:00 - 7d+17:20	06-Jun 21:38 - 21:58	Demo #10 (VK)
7d+17:30 - 8d+04:45	06-Jun 22:08 - 09:23	SAREX Robot
8d+04:45	07-Jun 09:23	QRT & Stow Hardware
8d+14:55	07-Jun 19:33	Begin De-Orbit

This Table was compiled by W3IWI with inputs from W3XO, WA4SIR and W5DID. It is provided for guidance only and is in no way an official list.

uplink or on the 145.55 MHz downlink, should coordinate with their local packet users and explain the situation. He received the interesting note shown below as a response. Apparently coordination in the Northern California area has not been done.

TO: ALL
FROM: W6GO - SYSOP W6GO DX PacketCluster
DATE: 16-May-1990 1525Z
SUBJECT: STS

I read with interest every delay of the latest ham-in-space effort. I am dreading the assault on the frequencies 144.95 and 145.55 MHz. Has anyone else made the comparison between DX-peditions who are supposed to respect net use of HF frequencies and contain their pileups and the space shuttle? There are allocated space frequencies in which "services" dare not tread. Just try to talk across town anywhere in the OSCAR window on 2 meters, and you will learn quickly that you should not be there. The policemen tell you that you are "out of the band", and you move. Fair enough. But the space shuttle announces months in advance exactly where it is going to take over, completely outside of the space frequencies. AND, the ARRL is supporting it, plus acting as the QSL manager for the effort. Is this a dual standard? If you are a DXer, stay in the "DX window". If you are an astronaut, you don't have to observe the "space window".

Will we be accused of "jamming" the STS? I hope not. The shuttle is quite welcome to connect to any of the seven nodes in our cluster that share 144.95 and do a SH/DX or make a DX announcement!

Ray Soifer, W2RS commented on W6GO's note as follows:

Judging by the text of the bulletin which Tom posted, however, the frequency coordination problem has just gone national! As W6GO said, his bulletin has been sent to all DX packet cluster sysops throughout the country, advising them to stay on 144.95. Here in the tri-state NYC metro area, 144.95 is also occupied by a DX packet cluster, KE2AY. I have been in touch with Joe and he has actually been posting our SAREX bulletins as they have come out. I doubt if there will be a serious problem of QRM to those trying seriously to uplink to the SAREX Robots, because the packet clusters generally use omnidirectional antennas while the shuttle uplinkers will be using beams. Your signal should override those from the packet clusters with few problems. Now, were any clusters or PBBSs to use 145.55, there WOULD be a problem!

Ray, W2RS

If squatter's rights mean anything, then the manned flight use of 144.95/145.55 well predates DX cluster occupancy. At least W6GO acknowledged that we gave them warning! *Tom, W3IWI*

Review the article in the March 1990 issue of *The AMSAT Journal* which explained why those frequencies were chosen. *Joe, G3ZCZ*

The SAREX Robot Timer

This note is to give you some additional information on timers involved in sequencing Robot packet transmissions.

Because we anticipate that the WA4SIR SAREX Robot will be bombarded with signals from tens or hundreds of ground-based users when STS-35 is flying over populated areas, it is not desirable for the Robot TNC and radio to use normal half-duplex packet procedures — the Carrier Detect (CD) signal would simply never drop!

The Robot will be running in a modified full-duplex mode. When the Robot copies a valid packet frame (or when it is time to send a beacon), the data to be sent is put into a buffer and a timer (which we call the FUD timer) is started. The Robot firmware then queues all other outgoing transmissions in the buffer until FUD timer expires (3 seconds later), and all downlink frames in the queue are sent in one long transmission. Many who had QSOs with the SAREX demo station at the AMSAT or HEATH booths at Dayton commented on how sluggish the 3 second FUD timer seemed to be when compared to normal packet operations.

Since the SAREX radio transceiver cannot receive when it is transmitting, users should insure that they remain silent and listen when the shuttle is transmitting. In other words, DO NOT RUN FULL DUPLEX ON THE GROUND! Leave your TNC in half-duplex mode (FULLDUP OFF) with CD active just like you do for normal VHF packet operations.

However you should be careful with the setting of two of your TNC's timers — DWAIT and FRACK. DWAIT is the time interval after your CD light goes out and before your transmitter turns on. You want to make sure your connects requests and acks are contained in the 3 second FUD timer window. If everybody runs the same DWAIT (like the typical 0.1 - 0.5 second values used for terrestrial packet), then everybody will be transmitting at the same time. Part of the key to your success when uplink QRM is heavy will be to pick a DWAIT that nobody else is using!

FRACK sets the time interval between your transmissions. After you send a frame,

your TNC waits for the FRACK time, and then waits for the Carrier Detect signal to drop, then waits DWAIT, and then tries again. You should make sure your FRACK is at least 3 seconds so that you are not transmitting when the Robot's FUD timer decides it is time for it to transmit — if you are transmitting at the same time, you will miss any packets the shuttle is addressing to you and you won't have a successful QSO.

Note that your DWAIT (how soon do I transmit?) and FRACK (then how long do I wait?) parameters and the need to stop transmitting so you can hear a reply are just like those you encounter when working a non packet DX-peditions pileup on HF. If the DX station has a pattern of listening for a few seconds (FUD timer) before transmitting, you may have better luck being the LAST station he hears, after the din dies down. The differences are that (1) the Robot is a computer and is very predictable and (2) the Robot can be working several stations at one time.

WA4SIR's SAREX mission on STS-35 is the ultimate DX-pedition! *.Tom, W3IWI*

Using LAN-LINK to work SAREX

Let me (G3ZCZ) also take this opportunity to answer some of the many questions I've received about using LAN-LINK to work the SAREX Robot. LAN-LINK 1.55 (and up) has features built in to it to allow you to make a connect with the orbiting SAREX Robot, while you are at the office, or even fast asleep. Like any other computer software manual, the LAN-LINK manual tells you what the controls (menus and function keys) do, it does not tell you how to use LAN-LINK. These application notes are intended to do just that.

Working SAREX

The first thing to do, is to set your 2 meter transceiver to receive on 145.55 MHz and transmit 600 kHz lower on 144.95 MHz.

Set the DWAIT and FRACK parameters as described above (read your TNC manual first). Set your deviation low so that your signal is not Doppler shifted out of the SAREX receiver's passband. You can do this simply enough by asking someone to listen to your signal's audio, while you gradually reduce your transmitter audio gain.

The next thing you ought to do is to configure LAN-LINK to capture to disk any packets addressed to or from the SAREX call sign. You do this by bringing up the AMSAT-OSCAR Menu and choosing the SAREX sub-menu. A [S] will be displayed in the status window when this option is active. The capture-to-disk file is opened by a packet header containing the SAREX call, and closed by another packet header not containing the call. When the file is open, the [S] will blink. Packet headers are considered to be lines with a '>' character in them. LAN-LINK thus considers both of the lines below as packet headers.

N4QQ*>G3ZCZN4QQ BBS>

If you use this feature for monitoring BBS traffic, the BBS prompt lines ('E.G. N4QQ BBS>') will not be captured to disk. Do not get your SYSOP to remove the '>' from the prompt line, or the ZAP feature will then not work.

A happy face will be displayed next to the 'S' in the [S] after the SAREX call has been heard.

Lastly, using the 'Terminal Menu', set the Terminal mode to 'Everything' to allow you to view all packets on 145.55 MHz.

Manual Connect Requests

If you happen to be awake when the Shuttle comes into range, then try to connect to it manually. LAN-LINK has two ways of doing this.

Try using the Alt-C function key. When you activate the Alt-C key, LAN-LINK will prompt you for the call. Enter WA4SIR, and LAN-LINK will try to make the connection. If for some reason it fails, push the Alt-R key and it will retry.

If you have copied at least one packet from SAREX, then push the F5 key and move the cursor down and over to the SAREX call sign or WA4SIR. Place it on any character in the call and push the "Enter" key. LAN-LINK will then try to make the connection. If for some reason it fails, push the Alt-R key and it will retry.

Automatic Connect Requests

Bring up the AMSAT-OSCAR Menu and choose the SAREX option. First make sure that the SAREX Call is set to WA4SIR. Then turn the Attack Mode ON. When the Attack Mode is set, this option will cause LAN-LINK to issue a connect request to the SAREX Call whenever a packet sent to or from it is heard. The mode is cleared when the connect is made (and does not retry out) or when the 'A' option is selected a second time, or when the Alert Call is cleared. If this mode is enabled, the Alert/SAREX Call prefix shown in the Status Window will indicate accordingly.

A happy face will be displayed next to the '>' before the call in the Status window once the connect has been achieved.

The Periodic Event Way

If you have a set of Keplerian elements, and know when the SAREX will be in your range, you can set LAN-LINK to start issuing a blind connect request to WA4SIR just before the Acquisition of Signal time, at periodic intervals through the pass, and to stop just after Loss of Signal time.

Bring up the Event menu, and select the Periodic Event option. Enter the start time, the finish time and the time interval between the connect/call attempts. The first connect that goes through will clear the event scheduler.

If you really want to make a connect with the SAREX, one of these LAN-LINK features ought to let you.

I strongly suggest that you test the automatic features before you sleep on it, just to be sure. From the SAREX menu, change the SAREX call from WA4SIR to that of your local Net Rom, The Link or KA Node. DO NOT set it to a BBS call.

The next time you see a packet from the Node, your station should try to connect to it and capture-to-disk to packets with the node's call in the header.

Don't forget to change the SAREX Call back to WA4SIR.

Afterthoughts

1. If you want to see an early version of what Ron will see as an ORBITER menu when he wants to control the SAREX Robot, temporarily change the SAREX call to be the same as your call and bring up the AMSAT-OSCAR Menu.

2. Send an edited summary of the contents of the real SAREX capture-to-disk file to SAREX @ W3IWI via packet, for a QSL card for a reception report. Just send copies of one or two packets containing all the calls.

3. You can also use this feature to try to connect to a DX-pedition running packet radio (such as the 4J6X DX-pedition that took place in late May) while you are at work. How about that! Now your station can work those future rare DX stations, and you won't need to be 'sick' at all. *Joe, G3ZCZ*

LAN-LINK is distributed as Shareware. For an evaluation copy, download it from Compuserve or send $5.00 together with your request to the AMSAT Office.

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AMSAT

CALL FOR PAPERS

By Bill Tynan, W3XO

The AMSAT-NA Annual Meeting will be held October 19, 20 and 21 at the Johnson Space Center (JSC), Houston, Texas. Coming, as it does, during a year in which two Shuttle missions are scheduled to carry licensed amateurs, JSC should be an exciting site for the meeting. With the added attraction of the Center's extensive museum and fascinating tours available, the attendance could easily break all records.

However, in order to have a successful meeting, quality papers must be presented. This announcement is to solicit appropriate papers. The Saturday Space Symposium, to be held in the JSC Visitors' Center Auditorium, is intended to feature talks on the latest in technology in both the manned and unmanned aspects of the Amateur Space Program. Talks on the Microsats and their use, are particularly invited. The session Sunday morning at the Ramada Kings Inn will feature presentations aimed at the beginning satellite user, including those trying their hands at the RS birds, AMSAT OSCAR 13 and the Microsats.

Those wishing to present papers are requested to send summaries to the AMSAT-NA office 850 Sligo Ave. Suite 600 Silver Spring MD 20910 by July 15. Those selected for presentation will be notified by August 1. Final texts will be due in electronic form, either E-mail or disc, by September 1. Reproducible figures and photographs will be due at the same time. Let's make this the best AMSAT-MA meeting ever. Get your summaries in right away.

AMSAT News

AMSAT-OSCAR 13 Orbit Under Study

Attentive satellite operators may have noticed that the AMSAT-OSCAR 13 orbit perigee has been decreasing steadily since mid 1988, the time that the final orbit change maneuver was completed. This effect seems to be a symptom of deep space perturbations (most notably from the sun and moon, which cause the eccentricity of an elliptical orbit to increase and decrease over a long term cycle) rather than one of orbital decay.

The initial perigee was around 2500 km and is now down to 1500 km. The perigee continues to decrease and if this trend continues, there will come a time when the perigee is inside the atmosphere and shortly thereafter, the spacecraft will burn up. Is this in fact what will happen?

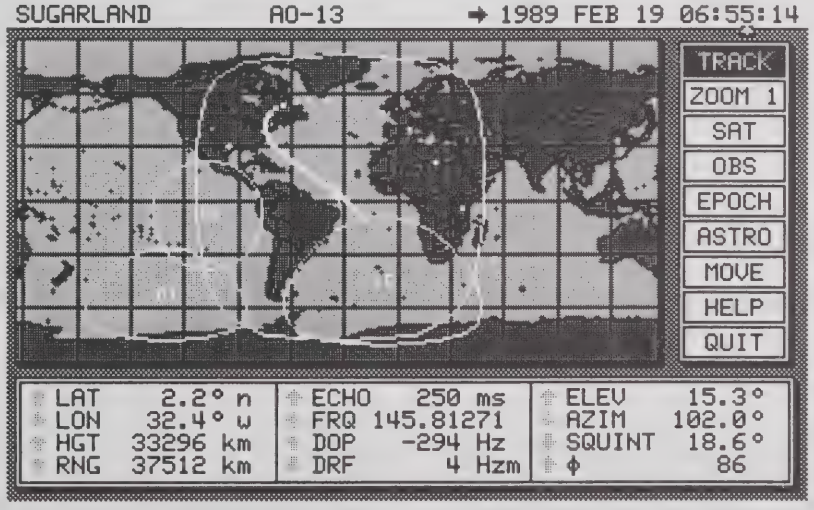
In May, Bob, N4HY and others from AMSAT went to Marburg Germany for the initial experimenters meeting to brainstorm on the Phase 3D satellite planned for the mid to late 1990's.

While there, they heard about a numerical study done by Dr. Victor W. Kudielka, OE1VKW of Vienna, Austria entitled "Long Term Perturbations for High Elliptical Satellite Orbits". He had built a model for the geopotential (earth's gravity field), and the luni-solar perturbations (effects of the moon and sun) on the orbit of AMSAT-OSCAR 13. His numerical study was done in BASIC which is not a language designed with highly accurate numerical work in mind. This was tied to a less than adequate model for the perturbations mentioned above. Nevertheless, his numerical model predicted that sometime in late 1996 or early 1997, AMSAT-OSCAR would reenter the earth's atmosphere and was the first person to clearly recognize that the perigee had been falling and would continue to do so. Knowing that the road to disaster is paved with inadequate celestial mechanical models, and being a skeptic, N4HY came home to try out a copy of the NORAD tracking package known as SPACETRK on this problem. It included what purported to be an adequate deep space model called SDP8. A deep space model is one used for satellites whose mean distance from the earth is larger than a few hundred kilometers. The outcome was shocking. The NORAD software predicted that the satellite would reenter the earth's atmosphere and burn up before 1993. This prediction was mentioned to a few people who had heard of the Austrian study along with skeptical comments along the lines of a mistake must have surely been made in

(Continued on page 21)

GET A BIRD'S EYE VIEW

From GrafTrak II™ and your IBM® PC



GrafTrak II™ provides real-time graphic display of a flat projection map which moves under the selected satellite(sat)/Sun/Moon/star coverage circle and updates once per second. Features include spherical projection views, graphic screen dumps to an IBM/Epson/Oki or HP LaserJet Series II printer, selectable lat/lon grid intervals, disk command files, automatic control of antenna rotators with full 180 degree elevation, coverage swath display for weather sats, multiple range circles, automatic sat switching, real-time ground track display, and squint angle display.

Silicon Ephemeris™ provides tabular data output to the screen, printer, or disk file for the following operating modes: 1 observer(obs) to 16 sats, 16 obs to 1 sat, schedule for 1 obs to 1 sat, window between 2 obs and 1 sat, rise and set times for 1 sat, time ordered rise and set times for 16 sats, Almanac for Sun and Moon, 16 obs to Sun/Moon, schedule for 1 obs to Moon, window between 2 obs and Moon, schedule for 1 obs to Sun, and optical visibility schedule.

The package includes an editor program used to construct and modify sat/obs data base files. In addition, a program to update data base files from bulletin boards, complete source code for a compatible rotator and receiver control program and several other utilities are included.

Requires an IBM PC, PC/XT, PC/AT, or true compatible, an IBM Color/Graphics Monitor Adaptor or true compatible, optional but recommended 80x87 math coprocessor, minimum 512K RAM, DOS 2.0 or later, and either two 360K floppy drives or one 360K floppy and one hard drive; the programs are not copy protected.

The complete package is $395 (List Price). Call for quotation. Check, money order, MasterCard, or VISA accepted.

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Software from the Office

Radio Amateur Satellite Corporation
P. O. Box 27, Washington, DC 20044

1. **ORBITS II** - For IBM PC and compatibles, 256k RAM memory, IBM Color Graphics Adapter (CGA) and compatible monitor, one 5 1/4 inch floppy diskette drive and DOS 2.0 or later. $35 members; $45 non-members.

2 **ORBITS III** - Functionally equivalent to ORBITS II but has been designed for use with the IBM Enhanced Graphics Adapter (EGA) and Enhanced Color Display. $45 members; $55 non-members.

3. **ORBITS IV** - Equivalent to ORBITS II but has been designed for use with VGA. $55 members; $65 non-members.

4. **N4HY QUICKTRAK 4.0** - For IBM PC DOS 3.0 or later. No 8087 math co-processors needed but will run much faster with it. Will run on 512k with CGA graphics but needs 640k for EGA. $55 members; $80 non-members; $200 commercial.

5. **INSTANT*TRACK*** - Required hardware: Any IBM PC, or AT, PS2, clone, etc. with at least 512k memory. Any display type is okay for the text mode screens, but VGA preferred. Graphics screens *require* EGA or VGA display. A numeric co-processor (8087 or 80287) is *NOT* required but is recommended. A mouse is *NOT* required, but can be used on the map screens. $50 members; $70 non-members; $200 commercial.

6. **QUIKTRAK FOR IBM** - For those IBM owners who do not have graphic capabilities (See Apple QUIKTRAK). $25 members; $35 non-members.

7 **AO-13 PSK TELEMETRY DECODING (IBM PC OR COMPATIBLE)** - 256k RAM, 360k drive, Serial Port. Monochrome or color. Menu Driven. Requires G3RUH demodulator. Decoded data displayed on monitor or printer and written to file for future reference. Documentation and telemetry information on disk. $35 members; $45 non-members.

8. **C-64 SUPERTRAC** - This is a combination of N4HY's Quiktrak program and enhanced graphics. This program provides sharp, clear, and colorful graphics with excellent scheduling flexibility. This program also has the ability to drive commercially available dual axis rotors. Disk only. $30 members; $40 non-members.

9. **APPLE QUIKTRAK** - Menu driven program for tracking and scheduling of Amateur satellites. Incorporates a very fast algorithm for finding usable passes of the satellite of your choice. Satellite pointing angles relative to your QTH and a "window track" mode are included. The "window track" feature identifies mutual "windows" between your QTH and other specified locations around the world. Includes menu driven utilities for data entry. Requires an 80 column card and 64k. $25 members; $35 non-members.

10. **SATELLITE HELPER** - Written by W7HR for the MACINTOSH, provides tabular data output of tracking and scheduling information for up to 10 satellites. Graphics displays include rectangular, polar and great circle world maps, and there is a VIEW mode which shows Earth as seen from the satellite at any time. A real-time mode will show data as it changes and is compatible with the KLM/Mirage antenna tracking interface. Data can be displayed on the screen or output to the Imagewriter printer. A propagation prediction package is also included which will calculate the maximum usable frequency (MUF) to any point, sunrise and sunset times, bearings and distances, and display the gray-line. Satellite Helper requires 1 megabyte of memory and an Imagewriter printer. $40 members; $50 non-members.

11. **C-128** - This is the ORBITS program that is specifically written to take advantage of the unique capabilities of the C128. ORBITS uses time-based incrementing with user-selected increments of time. This results in uniform time increments between data lines. The ORBITS Program features automatic page formatting and pagination. As many as twenty satellites may be entered into Keplerian files. It requires an 80 column monitor and a Commodore compatible printer. $30 members; $40 non-members.

12. **COMMODORE AMIGA** - Designed for the AMIGA operating in 80 column mode. Requires a minimum of 256k RAM. Translated to AmigaBasic. Runs under Workbench V1.1 or V1.2. Has the same features as the C-128 ORBITS but runs considerably faster. Has provision for mode and phase programming to alert you as to which transponder is active. 3 1/2 inch disk. $30 members; $40 non-members.

13. **C-TRACK 1** - for Color Computer 2 and 3. Requirements: 32k, disk drive and monitor. Uses CoCo 2 screen. Features: Text-based output to screen, printer, or disk. Utility for automatic conversion of AMSAT format Keplerian elements to disk file. 100 satellite database. $25 members; $35 non-members.

14. **C-TRACK 2** - Color Computer 3 only. Requirements: 128k, disk drive, B & W monitor. Same as C-Track 1 with the addition of graphics. Tracks satellite footprints over world map. Tracks one satellite at a time. $35 members; $45 non-members.

15. **WEBERWARE 1.0** - Process video pictures taken by Webersat-OSCAR-18. Available for IBM-PC's and compatibles. Super-VGA, VGA, EGA, and CGA graphics adapters supported. $30 members; $50 non-members.

AMSAT PUBLICATIONS

A Beginners Guide to OSCAR-13 by Keith Berglund, WB5ZDP. A step-by-step guide to hardware and operating procedures necessary to work the World through OSCAR-13. $7.00 in U.S.; $8.00 in Canada and Mexico; $10 elsewhere.

The Satellite Experimenter's Handbook by K2UBC, published by ARRL. Perhaps the finest book of its kind ever written for the Amateur. Beginning from scratch, this already classic text takes you to advanced concepts in an enormous scope and breadth of coverage. History, concepts, orbits, satellites, operating, station equipment, helpful hints, tracking aids - they're all here in this superb achievement in Amateur Radio publishing. Written by a recognized authority in the field, Dr. Martin Davidoff teaches mathematics at the university level and has been an AMSAT director for more than a decade. $10 in U.S.; $15 elsewhere.

Satellite Anthology The best of recent *QST* articles on Amateur satellite operation and hardware. $8 within U.S.; $9 Canada; $10 elsewhere.

Table 1 — Contents of the Telemetry Packet

Byte	Data Element	Comments
0 - 1	Byte count	Total number of bytes
2	Segment identifier	used for numbering frames when a long data sample is split into packets (reserve '0' for reconstituted ground station archives, or when the data is sent in a single packet).
3 - 8	time of entire data sample	(YY 0D DD HH MM SS) (ASCII to allow visual check) 0DDD is Julian date
9 - 10	software release identifier	two bytes to allow for lots of changes
11 - N	the binary telemetry data	

Telemetry Standard

(from page 3)

advantage over ASCII or RTTY in that the information copied at the ground receiving station is error free. The contents of the packet may be ASCII or binary. The lengths of the packets are different. At this time there is no standard. The contents of the telemetry packet from the MicroSats need one kind of decoding program, UoSAT, another, Fuji-OSCAR 20 yet another, and, if you want to copy experiment or payload data, you need yet another. The formats are also changing, that means if a year from now you want to analyze any of the data you have today, you will have to know when changes took place or you will get erroneous results. Why can't we have a standard for the telemetry in a similar manner to the standard BBS software used for packet messages?

Once the thrill of receiving satellite telemetry wears off, and it does so very quickly, without any means to know what that raw data means, people lose interest. That's why the MicroSat telemetry decoding information and software was published in *The AMSAT Journal*. Now even with software that displays the telemetry in engineering units in real time, watching temperatures drop as the spacecraft passes by each evening becomes boring after a while, people lose interest and go on to other things. In my opinion, the real thrill is in analyzing the data and investigating the relationships between different aspects of the spacecraft and its environment.

Analyzing the data requires a way of capturing, storing and exchanging data because real-time spacecraft passes are short. Real data analysis should be done using larger samples than that obtained at one location so sharing of data is necessary. Since most people doing the analysis would want to use data from more than one spacecraft, the ground station software should be *generic*. The same program should be capable of being used for all the current MicroSats, the one under construction by AMSAT-Italy, UoSAT-OSCAR 14, Fuji-OSCAR 20 and possibly Phase 3D and the Lunar Solar Sailcraft. The same software could also be used for Amateur Radio ground or terrestrial telemetry. The generic software would use different look-up tables, stored on a disk for different spacecraft and experiments.

Now to make generic software happen, we need a standard for telemetry transmission and archiving. *The standard does not define the contents of the frame, that remains the prerogative of the spacecraft designers.* The standard only defines the secondary header in the packet (the primary header is the AX.25 header) which tells the groundstation software a few things about the contents of the data frame. Thus the current UoSAT-OSCAR 14 and MicroSat telemetry formats can be used 'as is' with the addition of the secondary header. The different MicroSat telemetry packets (TLM, STATUS, etc.) can even be combined into one TLM packet.

The standard should also be flexible enough to allow for changes in the downlink without the need to have to release a new version of the software every time a change is made. When changes are made to the contents of the telemetry frame, each user can update their own look-up tables.

As part of my work in the real world, I've been looking at the Consultative Committee for Space Data Systems Recommendation for Space Data System Standards for Packet Telemetry. Now while most of it doesn't apply to us, adoption of a modified format (conceptually similar to the 'A' in 'AX.25') would provide a standard for both spacecraft software developers and ground system software developers. It would also provide a simple manner for identifying archived data.

This article proposes a two part standard, one used in the space segment or downlink, the other used in the ground segment for archiving the data. The two part standard minimizes the overhead on the downlink, allows for identification of the receiving station and also allows for identification and analysis of the data years later without errors due to the use of the wrong conversion coefficients.

The Space Segment

The amateur packetized data frame would fit into the data section of the AX.25 frame. KISS software will then not be required for the TNC. The state of the art of the implementation of KISS is not yet good enough for most non technical people.

Consider the following standard as a basis for discussion. The data should be in Binary rather than in ASCII. This will provide the packing to minimize the packet length. Basically, the spacecraft would put the information shown in Table 1 as a secondary header into the data area of the AX.25 packet before the telemetry. This information serves to identify the data to the groundstation software.

Each of the actual binary telemetry bytes contain different types of data such as status or engineering units. When the spacecraft telemetry equations are published, they can be published in the format shown in Table 2. You will note that it is very similar to that already in use. Once the spacecraft data channel assignments are published, the type of information in each byte is known and the ground station software can process it accordingly.

(Continued on page 20)

Table 2 — Extract from Typical Published Spacecraft Telemetry Conversion Data.

Spacecraft Name	
Byte	*(Secondary header)*
0 - 1	0090 Byte count of 90
2	1 Segment identifier (all telemetry in one packet)
3 - 8	time of entire data sample (YY 0D DD HH MM SS)
9 - 105	launch software release identifier
Data Area	
Byte	
11	8 bit Status, Switch states
12	8 bit analog Quadratic, Solar current (coefficients 0,0.34,45.3)
13	16 bit analog Quadratic, charge circuit voltage (coefficients 0,2.45,12.67896)

etc.

In reality, each type of data element would be given a number or letter combination for identification.

AMSAT Director Elections

Below are unedited biographical and election statements provided by the candidates running for election. Your ballot is inserted into this issue of *The AMSAT Journal*. Please follow the directions on the ballot card to cast your vote and return it to AMSAT Headquarters as soon as possible, and in no case any later than September 15, 1990. The candidates are listed in alphabetical order.

Please follow the directions given on your ballot card to cast your vote. Then, return it to AMSAT Headquarters as soon as you can. Your ballot must *arrive at Silver Spring, MD no later than the Sept. 15 deadline.*

John Champa, K8OCL

The most important objective of AMSAT is service to the membership. Foremost among these services is the launch of reliable, easy to use satellites. When we launch a satellite, a new generation of activity is automatically set in motion. Experiments are conducted. Education in the sciences is promoted. Publications, including software, are provided. Technology is advanced. Our members expect all these activities to occur and our bylaws demand that they occur, but they will happen in any event. The satellite remains pivotal, and is the catalyst of our organization. The design, construction and operation of Ham friendly birds is our life blood. You need only look at the rapid membership growth following the deployment of OSCAR-10, and again after OSCAR-13, to come to the same realization. While I strongly support an international Phase 3D Satellite Project as proposed by AMSAT-DL, I continue to hope that we will someday have the financial resources to build a geostationary Phase-4 bird. The earliest either of these extremely ambitious projects will likely be completed is 1995. AMSAT needs to consider additional alternatives for satellites in the interim, especially linear transponders to support general Amateur voice communications. If elected to your Board, I will continue to do all I can to maintain our organization's focus on this basic priority.

My professional position is manager and chief engineer for advanced telecommunications systems (including satellites) with the Unisys Corporation. I have been with AMSAT since the days of OSCAR-6 (Life Member 1069), and I have served at the vice president level under three consecutive AMSAT administrations (currently Executive Vice President). As an officer of our organization, I have participated in AMSAT Board of Director's meetings for 9 years, but have never had the privilege of voting. My experience enables me to take technical competence, industry relations and resources, and sound business management perspectives to the Board of Director's meetings. Electing me to the Board will also enable me to take my vote.

Tom Clark, W3IWI

Tom has been active in AMSAT since the OSCAR 6 days. He has been on the AMSAT Board since 1974, was Executive V.P. from 1975-1980 and was Pres. from 1980-1985. He helped develop the Phase 3 telecommand station network. Adaptations of his BASIC satellite prediction program are in use by most active satellite users and has been a major source of revenue for AMSAT. Tom conceived the idea of digital store and forward satellites embodied in the PACSAT, JAS-1 Mode JD and RUDAK projects and coordinated the SAREX-2 shuttle packet radio project. His packet radio bulletin board system serves the Balt./Wash. area and is among the most active in the world. He has successfully coordinated several "big dish" EME sessions and holds the dubious honor of having earned 432 MHz WAC in under 12 hours.

Tom is a radio astronomer at NASA/Goddard where he directs a project to measure continental drift using radio telescopes all around the world. Of his contributions to Amateur Radio, Tom wants to be remembered for two: The "Phoenix from the Ashes" resurrection of AMSAT following the loss of Phase 3A; and, his long-term goal of education.

Tom is co-founder of the joint AMSAT/TAPR DSP project. He was leader of the group that did the TAPR PSK modem which is the basis for the PacComm PSK-1 and is still the most popular modem for Microsat and FUJI in the US. He wrote the first widely used computer program for tracking satellites that was based upon solving Kepler's equations and almost all programs in the AMSAT software exchange have been a derivative of it.

Jack Crabtree, AAØP

I am honored to have been nominated as a candidate for AMSAT-NA Board of Directors. Although many of you know me already, it might be well to summarize my amateur radio and AMSAT history. I have been an active amateur radio operator since receiving my ham ticket in 1961 at the age of 13. I served in the U.S. Navy as a Radioman from 1967 to 1970 on Adak (one of the Aleutian Islands) and at Cam Rahn Bay, Vietnam. I became active on Oscar 6 during my last year at Arizona State University in 1973. I have remained active on amateur radio satellites since those exciting mode A days. I can be found operating currently on Oscar 10 and 13, FO 20, RS 10/11 and am in the process of finalizing Microsat packet capability.

For the past two years I have served as AMSAT-NA Vice President of Field Operations, responsible for the field organization (your local Area Coordinator) and hamfest support, amoung other duties. During these two years, as an example, I organized and ran (with lots of great help) the AMSAT Dayton Hamvention booth where each year, a record gross income was experienced. I served as a member of the final integration and test team for both Oscar 13 and the Microsats during which, I obtained the donation of test facilities from Martin Marietta Astronautics Group, my employer, for thermal vacuum and vibration testing. I operate a local AMSAT packet BBS in the Denver Area and am net chairman for a local AMSAT 2 Meter FM voice net. In short, I am an active amateur satellite user as well as active volunteer AMSAT Officer.

I believe I can make significant contributions to AMSAT and the Amateur Radio Satellite Program as a member of the Board of Directors. I support AMSAT participation in the Phase IIID program and the continuing development of the Phase IV geosynchronous satellite program. I have a personal priority of keeping amateur radio satellites "amateur". I believe that by increasing membership services and thus membership, participation of groups such as repeater clubs and packet organizations, partnerships with educational groups and universities, we can finance these ambitious projects without making deals with commercial interests. I am greatly interested in promoting science and

mathematics with our school-aged youngsters by the use of amateur radio and Oscars in the classroom. To summarize, I have the vision, the experience, and the energy to promote constant improvement within the AMSAT Organization as a member of the Board of Directors.

Dr. Junior Torres de Castro, PY2BJO

AGE: 57

NATIONALITY: Brazilian

PROFESSIONAL DEGREES: Civil Engineer, Electrical and Electronics Engineer, Geologist, Geophysicist, PhD in Physics.

PROFESSIONAL ACTIVITY: Owner of deep (water well) drilling company. Cattle farms in the State of Mato Grosso. Coffee Plantation in the State of S. Paulo.

NON-PROFESSIONAL ACTIVITIES: Amateur Radio, Astronomy, Metereology, Computing, Photograghy, Music.

HIGHLIGHTS IN AMATEUR RADIO: Has been involved with Amateur Radio for 45 years, since age of 12. Life member of LABRE (Brazil's national association), long time AMSAT member since 1972 and a Life Member since 1982. Known in his country as a supporter of activities and modes to promote new interests among old timers and youngsters alike, such as moon bounce and packet radio. His work, through profession and Amateur Radio, has made him well known and influential in government circles. More recently, has been dedicating his full spare time to BRAMSAT (AMSAT-Brazil), of which he is President, specifically to his dream project, the renowned DOVE Microsat (OSCAR-17), which he fully sponsored and which is now in orbit, about to send out its spoken, digitized, children's messages from all over the world. He is credited with other major contributions to the Amateur and satellite service, both in work and funds, and has been a close cooperator with AMSAT-NA, including numerous conference trips to the U.S., Europe, South American countries and Africa. His repeated presence at the Kourou (French Guiana) rocket launch gantry, since OSCAR-13, has become a familiar sight for all who live and love AMSAT and all it can do for hamdom's future.

AMSAT's future: Although, under international I.T.U. regulations, the Amateur Satellite Service is classified by itself as an individual service, it certainly cannot be imagined divorced from the Amateur Radio Service, being, as it historically is, since our first OSCAR back in 1961, an offspring of the traditional effort of the many who came and always should come from the latter Service.

AMSAT's future is bound to Amateur Radio's health. Much is being said about incentive to our younger generation. We now have the tools, better than we ever had before, to lead these youngsters in the direction which will guarantee AMSAT's survival, when some of its present leaders have gone into other orbits. Our present Microsats are here, as valuable interest generators, just waiting to be used for this purpose. If we do it now, in schools and in universities, in radio clubs, among boy (and girl) scouts, even in associations and congregations that do not primarily cater to ham radio, if we give these youngsters a good chance to participate and contribute by way of a well devised program of junior operators, builders and observers, then we will have cared for AMSAT's long term future. And such a program should, among other steps, include reactivation of our laboratory in Boulder, Co. to which this writer would be willing to contribute in funds and work.

Courtney Duncan, N5BF

Courtney Duncan, N5BF, has been licensed since 1972, is an AMSAT Life Member, and is a member of AMSAT-UK. He began monitoring OSCAR-6 as a Novice but was unable to afford equipment for uplinking until OSCAR-7. He is married to Viann Duncan, WD5EHM, who is expecting their third child. Major involvement with AMSAT began in 1980 shortly after the loss of Phase III-A. In 1983 he wrote the AMS-81 tracking program for the Sinclair ZX-81 computer. In 1985 he earned a second bachelor's degree in Electrical Engineering motivated in large part by a desire to learn more that was applicable to Amateur Radio and satellite work. Previously, he had worked in radio and TV following graduation from the Baylor University School of Music in 1978. He worked at the Johnson Space Center in 1983 and was involved with planning for the first "Ham in Space" mission (STS-9). Since 1987, he has been employed at NASA's Jet Propulsion Laboratory. He has been involved with JPL Amateur Radio Club (W6VIO) activities including the Voyager 2 - Neptune Commemorative and AMSAT Launch Nets. He is a past officer of the JPL Club and cites this along with twenty one years of church work as significant experience with volunteers and volunteer organizations. In 1988 Courtney was named AMSAT Vice President for Operations. He is trustee of the AMSAT-NA Pacsat, AO-16, and will be in charge of mission management once the satellite and ground based software have sufficiently matured. He will also be a point of contact between AMSAT-NA and the other Microsat managers. Current programs under his direction are: AMSAT News Service, Command Station Development Program, Digital Gateways, DX Operations, HF Nets, Operations Net (on AO-13), Orbital Data Management, Phase-IV Operational Studies, Software Exchange, Techno-Sports, Telemetry Archive, and Telephone BBS Network. The continuation and expansion of these and other programs and projects is planned. Courtney seeks election to the Board in order to lead toward these goals: 1. Continue to build a strong and diverse Radio Amateur Satellite Service by keeping satellites of various types available to the current user base and promoting activities on them that will facilitate growth of that user base. Technical requirements for new and experienced users should be relaxed. 2. Recognize and promote different constituencies. The satellite service by nature consists of enthusiasts in diverse branches of radio and space technology. This diversity is evident in the list of programs given above. These groups should be recognized and encouraged as integral parts of the overall movement and should be brought into mutual service and support. 3. Make the steps smaller at all user levels so as to involve as many people as possible. From entry to advanced operation, hurdles should be eased for those desiring routine access to satellites, challenges provided to those desiring them, and communications promoted among everyone. Our goal must be to allow pleasurable and meaningful participation while encouraging cooperation for the benefit of all. Courtney is available to all AMSAT members for suggestions and consultation and appreciates your support for AMSAT programs.

Joe Kasser W3/G3ZCZ

Joe Kasser, W3/G3ZCZ, AMSAT life member LM-105, became a ham in 1968 with a code-free license (G8BTB). Joe has been active in the OSCAR program since the days of Australis-OSCAR-5. Joe began his AMSAT career by taking responsibility for the *AMSAT Newsletter* in 1974, and served as its editor and as that of its replacement, *ORBIT Magazine* until 1981. In 1989, at the request of the BoD, Joe picked up where he had left off and started *The AMSAT Journal.*

Apart from satellites, when he finds the time, Joe is also interested in construction, DX, contests, applications of packet radio and micro-computers. Joe is the author of the LAN-LINK, WHATS-UP and PC-HAM Shareware packages for the PC. His writings have been published in *QST, CQ, 73, Ham Radio,* and *BYTE* as well as in several other US and foreign publications. Joe also has two published books about the application of microcomputers to Amateur Radio.

Professionally, Joe is an Electronics Engineer by training. He immigrated to the USA in 1970 and worked on the science

stations taken to the Moon on the Apollo 15, 16 and 17 missions. Joe subsequently worked for COMSAT and has more than 20 years of experience in Aerospace, particularly in the fields of Systems Engineering, Telemetry Tracking and Control and the Man-Machine Interface. From 1981 to 1986 Joe successfully designed, built and managed the installation of the control system for the SEGS-1 Solar Field Electrical Power Generation System. The development work was performed in Jerusalem, Israel, the installation is in Southern California. As such Joe is used to working in a geographically distributed organization such as AMSAT. SEGS-1 and its successors now provide more than 95% of the world's commercially generated solar electrical power. Joe is now once again directly involved with the professional space program, being employed by Ford Aerospace. Although Joe has a Master's degree in Telecommunications, he is continuing his studies in Systems Engineering and Management.

Joe has taken part in many AMSAT-OSCAR meetings and demonstrations. He was active in the AMSAT-GOLEM 80 microcomputer project. Joe proposed the AMSAT-NA QSL bureau, the satellite groundstation gateway concept, the band plan for the satellite communications passband (together with G3IOR) and was the first to introduce the term Phase-4. He is currently proposing an Amateur packet telemetry standard.

Joe's background and experience provide him with a unique outlook. He has both the technical background to communicate with the 'hard core', yet the nature of his work over the years has kept him close to the non-technical types who are the bulk of the AMSAT membership, who rely on AMSAT publications, rather than a formal university education for their technical education. If elected to the BoD, Joe would help the BoD stay in touch with the rank and file members in the field, would make the organization more responsive to the needs of the members, would explore the educational aspects of telemetry from space, assist in setting priorities, and provide direction for the future.

Doug Loughmiller, KO5I

Doug serves as AMSAT President and General Manager. He has served as President since 1988 and was hired as General Manager in September of last year, becoming only the second full-time paid employee AMSAT has on the payroll. Prior to taking on these roles Doug had held a number of positions within the AMSAT organization including: North Texas Area Coordinator, Assistant Vice President of Operations for Spacecraft Operations, Vice President of Operations and Vice President of Field Operations. He was recognized for his outstanding achievement in the area of Field Operations during the 1987 annual meeting in Detroit, MI. Throughout his tenure with AMSAT Doug has been actively involved in many different facets of the organization's management including: fund raising, convention support, information dissemination, public relations, volunteer recruitment and coordination, financial management, publications, resource management and inter-organizational liaison. He is a veteran spokesman on AMSAT's behalf with well over 100 public presentations to his credit. He served as a co-primary net control station for the15 and 20 meter international nets from 1981-1984. Doug was first licensed in 1972 and became an AMSAT member in 1973 while still a student in high school. He has been an active satellite enthusiast since OSCAR-6. He has held an Amateur extra class license since 1981. In addition to his American callsign Doug holds the callsigns of ZF2IP in the Cayman Islands and G0/KO5I in the United Kingdom.

As AMSAT President and General Manager Doug has strived to make improvements in many different facets of the organization's activities. "It is my goal to see AMSAT reach its fullest potential as an organization," he explains "I have long contended that AMSAT is first and foremost a people organization. We are able to achieve the significant things we accomplish due only to the very talented people we have within our organization who are willing to put so much of their time and energy into our ambitious projects. It is my objective to create an environment that will allow capable volunteers to gravitate towards the organization and to get involved in our programs thus creating a climate that will foster productive output regardless of what particular talents a given volunteer brings to our programs. I see a bright future for AMSAT, the possibilities are almost endless in terms of what projects we could become involved in over the next few years. In the final analysis, service to the members and providing the types of resources they feel are useful should be the ultimate criteria for establishing which programs we should undertake."

"I feel that my background as a manager of this organization would make me a valuable asset as a voting member of the board. I want very much to see AMSAT move forward into the decade of the '90s with the same trend-setting vision we have had over the history of our organization. As far as I'm concerned, the OSCAR satellite program is the best part of the Amateur Radio hobby. I want to serve AMSAT in a role that will allow me to help mold the future and insure that OSCAR will be a vital part of Amateur Radio for some time to come."

Ray Soifer, W2RS

Ray Soifer, W2RS, has been an integral part of AMSAT-NA's senior management team since 1969 and served on the BoD from 1972 to 1974. An investment banker by profession with over 20 years of Wall Street experience.

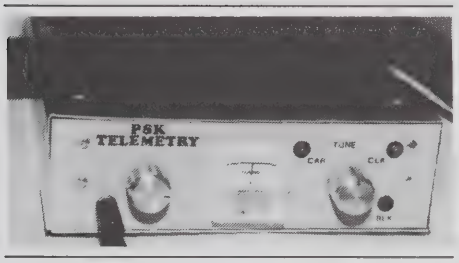
Currently Vice President for Special Projects since 1988, he has also been Financial Advisor and Chairman of the Investment Committee (1972-84) and Chairman of the Management and Finance Committee (1984-88). Among the duties of his current office, Ray has chaired the Budget Committee (1988-89) and the BoD-appointed committee to oversee the General Manager (1989-90), was responsible for the 1988-89 revision of the Bylaws and Articles of Incorporation, and serves on our WARC-92 preparation panel.

Holder of an MIT BSEE as well as a Harvard MBA, Ray's technical contributions to AMSAT have ranged from managing the Australis-OSCAR 5 propagation research program that established the feasibility of Mode A to MicroSat orbital determination and object identification. Ray is an active, long-time author for AMSAT publications and a frequent speaker at amateur satellite meetings in the U.S. and overseas. Numerous articles under his byline have appeared in QST on satellite and EME communications. A member of the DXCC Honor Roll, he also holds Satellite DXCC (#13), WAC (#6) and WAS (#52).

"If returned to the BoD by the members, I will strive to represent their interests to the best of my ability as I have always done. For over 30 years, the satellite program has been responsible for much of amateur radio's technical progress. As a Director, I will help to keep it soundly conceived, soundly financed and soundly administered."

Remember, your ballot must be removed from the binding of this issue, filled out and mailed in time to reach AMSAT Headquarters in Silver Spring, MD on or before September 15, 1990.

Modifications to the G3RUH 400 Baud Telemetry Demodulator



By Ed Krome KA9LNV
1023 Goldfinch Rd.
Columbus IN 47203

As a reasonably active satellite user and incurable experimenter, the launch of AMSAT-OSCAR 13 made me think more about what the satellite itself was actually doing, rather than just what I was doing though it. So, I purchased a circuit board[1] and built up the AMSAT-OSCAR 10/13 400 baud PSK telemetry demodulator, as designed by James Miller G3RUH. This design was originally published in the U.S. in *Ham Radio Magazine* April 1985, pg. 50. Many of these decoders are in use worldwide.

Neither construction nor calibration were particularly difficult, but you are advised to follow the calibration instructions carefully. The use of a Data (Carrier) Phase Lock Loop (PLL) center frequency of 1500 to 1600 Hz seems to provide good operation with a variety of Japanese-made radios. An accurate setting of the Clock PLL lock frequency is especially critical for proper operation. Note that variations between different 4046 PLL integrated circuits caused some builders problems in frequency adjustment. To minimize these problems, G3RUH has circulated a list of modified component values which make adjustment of the PLL's to the correct frequencies much easier. I have included the list of changed components and new values at the end of this article[2].

One problem I encountered during alignment was that I kept smoking IC2 and IC6, which are 4030/4070 XOR's. The problem turned out to be caused by my choice of a meter function select wafer switch. This was a junk box item that turned out to be of the short to ground between positions variety. Switching momentarily shorted the XOR output to ground and blew the IC. Check your switch with an ohm-meter to insure that the switch cleanly breaks one contact before it makes the next one.

One slight problem remained before getting the demodulator into operation. Miller's design is adaptable to a wide variety of computers and terminals and therefore has two types of outputs available. The first is a TTL parallel output. It is designed to interface to the British BBC Acorn computer, a rare creature indeed on this side of the pond. The second is a serial output at TTL voltage levels. During construction, I (as have most U.S. builders) adapted the demodulator for 1200 baud serial output. In order to insure compatibility with the requirements of most U.S. standard serial interfaces, it was necessary to add a few chips to convert the TTL level serial output to the standard levels of RS-232C, see Fig. 1.

TTL uses 0 and +5 VDC voltage levels, whereas RS-232C requires output levels of -3 to -15 VDC for a logical 1 and +3 to +15 VDC for a logical 0. The most common approach to level conversion is to use a 4049 inverter/buffer and a 1488 level converter IC. This approach worked fine, but had one slight aggravation. It required 3 power supplies, of +5, +12 and -12 VDC. The power supply was heavier than the demodulator. There must be a better way! Review of the demodulator voltage requirements showed that the +5 VDC supply was really only needed if one was ever going to use the TTL output level. Strike that one. The 4050 output buffer chips are CMOS and will run just fine on +12 VDC. The +12 VDC requirement is the main power source for the entire device and the -12 VDC is only required to satisfy the RS-232C specification. But, generating -12 VDC from +12 VDC (cheaply) presents some interesting problems. Re-

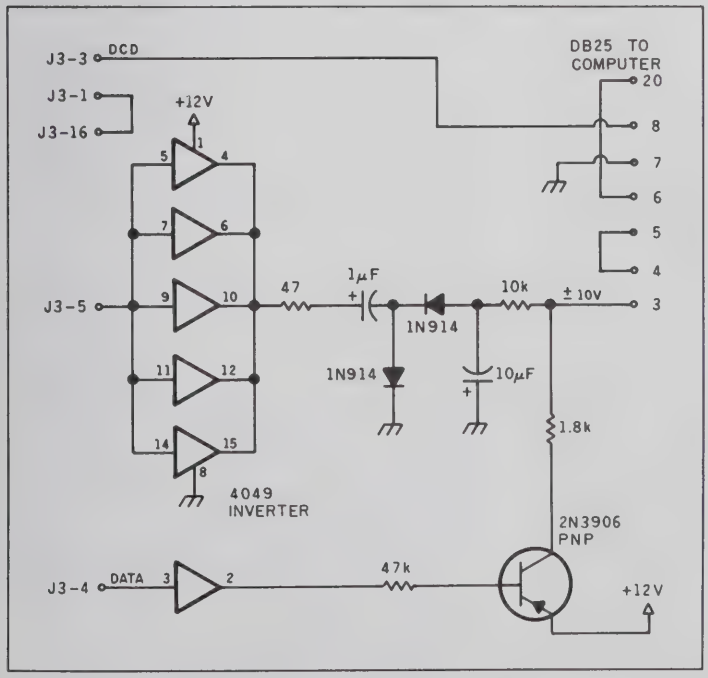


Figure 1 — Output level converter. RS-232C output from G3RUH 400-baud PSK demodulator.

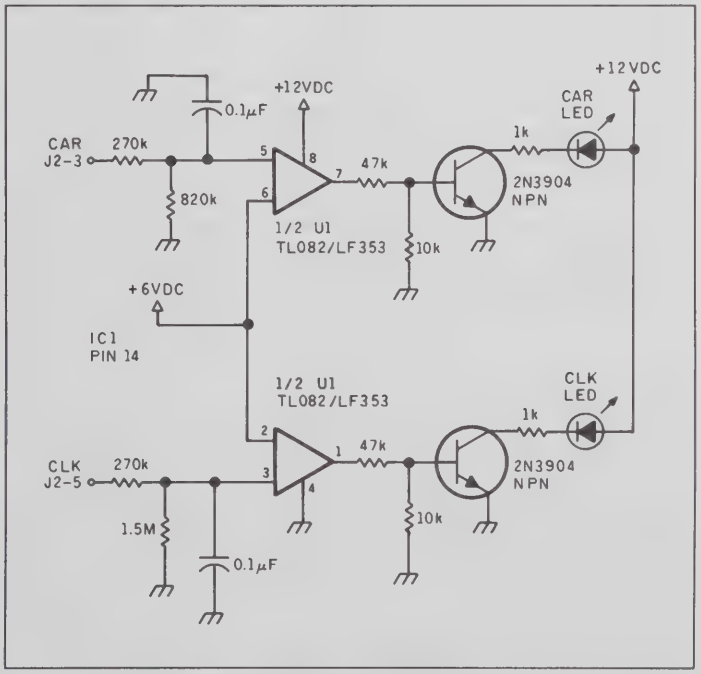


Figure 2 — LED tuning indicators for CLK and CAR on G3RUH 400-baud PSK telemetry demodulator.

view of a few pounds of literature turned up an interesting device called a "charge pump", which looked like just what was needed.

A charge pump is a circuit that uses the negative half of a sine wave to build a negative charge on a capacitor. A few components and a source of approximately 1 KHz sine wave are all that is required. The G3RUH demodulator has a fine source built in, namely the serializer clock. This is available buffered at output connector J3 pin 5. In order to reduce the load on the output buffer and increase drive current capacity, I paralleled 5 sections of an added 4049 CMOS inverter and used them to feed the charge pump. This arrangement produces a usable source of low current negative voltage.

The remainder of the circuitry, consisting of a 2N3906 PNP transistor and 2 resistors switches the +ve and -ve voltage available at the data output for the computer. The unused section of the 4049 inverter is used to invert the data stream from the demodulator serial output (J3-4) and drive the 2N3906. When the base of the 2N3906 is driven high, the transistor is shut off and the -ve voltage appears on the output pin. When the base is driven low, the transistor conducts and connects the +12 VDC line on its emitter to the output pin though a 1.8K resistor. This connection has a higher current capacity than the still connected negative supply, therefore the output pin assumes the high state. Selection of the relative values of the 1.8K and 10K resistors determines the voltage levels and symmetry of the output. These values were selected empirically, which is a fancy way of saying trial and error. A scope shows quite symmetrical voltage excursions of +/- 10 VDC during data flow, which matches the RS-232C standards quite nicely. The required circuitry is non-critical and can be built up either separately or on the unused socket locations on the demodulator circuit board.

A few other wiring changes are required for proper operation. Jumper J3-1 to J3-16 to apply +12 VDC to the 4050 buffers. Wire J3-3 to pin 8 on the DB25 output connector.

Some decoding programs such as the excellent "P3C" from AMSAT Australia or Project OSCAR Inc.[3] require that the DCD (Data Carrier Detect) line be asserted to acquire data, which comes in 512K blocks. This is supplied by the block indicator. Other wiring for a standard DB25 connector in the RS-232C output is noted.

Although I have not experienced the need, some computer serial ports may require + and - 12 VDC on the DCD line rather than 0 and +12 VDC that this wiring scheme supplies. A second inverter section and 2N3906 with associated circuitry would provide it.

With the DB25 wired as shown, a pin-to-pin cable for pins 3 through 8 and 20 is all that is required to connect the demodulator to a DB25 serial port on an IBM-PC, XT or AT. Now only one +12 VDC power supply is needed to provide RS-232C data output instead of 3, and it works fine.

After using the demodulator for a while, a second need became evident. In order to tune the unit to properly demodulate the bird's telemetry, you must tune for CLK (Clock) Lock and CAR (Carrier) Lock by switching the meter between these two settings and tuning for maximum meter indication. Then you switch to the center TUNE position and center the needle. As Doppler shift varies the received frequency, it is necessary to tune the demodulator (or the radio) to keep the TUNE meter centered. This works fine and is not hard to do, but it does require a lot of switching. In order to simplify tuning, I added a pair of indicator LED's to monitor the status of the CLK and CAR PLL's, see Figure 2

That way you can leave the meter in the TUNE position and still monitor all three functions simultaneously. The circuitry for these PLL status monitors was adapted from that used by G3RUH for the lock indicator LED on his 1200 baud PSK modem, as used with Fuji-OSCAR 20 and the MicroSat's. The indicator consists of a dual section BiFET input operational amplifier and 2 transistor LED drivers. The op amps are each wired with one input to the appropriate PLL meter indicator line and the other referenced to the +6 VDC line in the demodulator. This circuit can be built up either separately or on one of the unused socket locations on the demodulator board itself.

When wiring this circuit, the easiest places to tap into the demodulator's circuitry are as follows:

- For the +6 VDC reference, solder a lead from IC1 pin 14 to pins 2 and 6 of the LF353.
- For each PLL connection, solder to board connector J2, at pins 3 and 5 for Carrier and Clock, respectively.

Note that the values of the resistors in the op amp input networks are different. These were determined empirically to give quite good correlation between the movement of the meter (and ability of the demodulator to extract data) and the lighting of the LEDs for each function. When both LEDs light, the demodulator will get the signal. A good place to mount the LEDs is on the front panel of the demodulator above and to either side of the switch near their respective functions.

(Continued on page 30)

Telemetry Standard

(from page 15)

Byte types can be defined in various ways. Some of those in use today are as follows:-

Engineering units : 8 bits, using the current quadratic approach

an^2 * bn + c

to the decoding equations. This technique is in use in the MicroSats today.

Engineering units : 8 bits, using the approach of

a * (n-b)

to the decoding equations. This technique was used in Fuji-OSCAR 12.

Engineering units : 16 bits, using the current quadratic approach to the decoding equations (first byte is the least significant byte).

Status Bytes: containing 8 bits of individual status.

Engineering Units : downlinked as two 4 bit nibbles, as used in the current STATUS telemetry.

Mixed Bytes (Type L and H) : in which one nibble of a byte is four status bits, the other nibble being an engineering unit. L identifies the status nibble as being the Low nibble, H identifies it as being the High nibble.

In this manner, all telemetry (engineering units and binary) can be transmitted in the same SPACECRAFT-1>TLM packet as shown in Figure 1. No more STATUS, WASH or BCRXT packets would be needed. All other packets on the digisats would be communications related. WEBER and UoSAT would have experiment packets with the data imbedded in the same format.

Stations monitoring the digisats for communications purposes, could inhibit the binary TLM displays with their 'LID' or BUDLISTs. The spacecraft time in the (header) data would provide accurate time information, irrespective of the groundstation's computer or TNC clock setting.

The software release identifier would be changed each time the spacecraft software is uploaded. This way when a channel assignment is changed to a different sensor, or the whole format is changed, the look-up tables in the ground station software can updated, yet later post archival storage processing won't bring up the wrong values, and cause people to write in and ask about them. An example of this type of change could be when a channel assignment changes from an array current to a battery voltage.

This proposal adds 11 bytes to the raw data packet on the downlink. However

(Continued on page 24)

AMSAT NEWS

(Continued from page 13)

the usage of the program. After all, the energy in this orbit is huge and surely this perturbation would no longer be dominant after drag became a large enough force to start bringing down the apogee a significant amount per day. A discussion was held with KA9Q who contacted the Millstone Hill tracking station and someone was enlisted to do a long term study on the orbit of AMSAT-OSCAR 13. We still await the outcome. Shortly after N4HY did his numerical run he told a few people about the numerical prediction of disaster. This being too big a story to be kept quiet for long, Franklin, N6NKF heard the rumors and also tried the SPACETRK program and got similar results. Franklin was also incredulous and wrote his own tracking program which made significant usage of a nearly complete lunar orbit theory, known as Brown's Lunar theory. He also used a collection of formulas from G.E. Cook's 1962 paper in *The Geophysical Journal of the Royal Astronomical Society* entitled "Luni-Solar Perturbations of the Orbit of an Earth Satellite" to predict lunar and solar perturbations on the orbit of AMSAT-OSCAR 13. It was a large piece of work and in the end gave very similar results to SPACETRK. Franklin has also studied these perturbations analytically and been able to derive which are the operant resonances forcing this perigee decay. This and the results of the numerical studies will be detailed in a paper to written for the *AMSAT Journal* and to be presented at the AMSAT-UK Colloquium in Surrey. Spurred on by this work, and desiring yet another independent verification, Bob wrote a large differential equation solver program which does numerical integration of the orbit. Gravitational attractions included Brown's lunar theory, a high order expansion of the earth's geopotential, and an extremely accurate model, using spline interpolation of tables of solar positions, to get very accurate solar perturbations on the orbit. This information was fed into an extremely high order, exceedingly slow and accurate numerical integrator and run on a supercomputer with 128 bit registers used for prevention of some numerical problems (round off). The net results agreed with both the N6NKF derived model and the SPACETRK results in the details.

It would seem very easy to draw conclusions from the data generated from numerical experiments. At this point the data all appear to say that AMSAT-OSCAR 13 will cease to function by the end of 1992.

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P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	−20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	−20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	−20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	−20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

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The numerical runs we are talking about above are covered up with ways to make large errors. Franklin and Bob are both experienced computer users and understand the kinds of things that can go wrong with this kind of study. Bob states that "the prognosis for AMSAT-OSCAR 13 looks bad but that we have internal medicine men playing neurosurgeon if you will allow me to make an analogy. This means that we have all the necessary formal training to do the job but we haven't got the necessary experience to make major predictions of disaster without asking those who do this professionally to take a look".

As such, AMSAT has contacted various institutions, including Millstone Hill (the radar complex that provided early orbital data during AMSAT-OSCAR 10 and AMSAT-OSCAR 13 burns), NASA's Goddard Spaceflight Center, and other NASA Centers in order to have the most complete possible analysis of the problem performed by experienced professionals.

Any decisions or plans on the part of

AMSAT must wait until after these results are obtained and fully understood. *Bob, N4HY*

AMSAT-NA Operations Net Schedule Announced

AMSAT Operations Nets are planned for the following times. Mode B nets are conducted on an AMSAT-OSCAR 13 downlink frequency of 145.950. Mode J/L nets are conducted on an AMSAT-OSCAR 13 downlink frequency of 435.970.

Date	UTC Time	Phs	Mode	NCS	U.S. Day
26 Jun 90	0115	144	B	N5BF	Monday
Orientation Change to 210/0					
09 Jul 90	0000	184	B	N5BF	Sunday
16 Jul 90	0115	130	B	N5BF	Sunday
27 Jul 90	0030	130	B	N5BF	Thursday

Transponder Schedule for AMSAT-OSCAR 13 Effective 5 MAY 90. The present transponder schedule for AMSAT-OSCAR 13 is as follows: Mode-B: MA 000 to MA 100; Mode-JL : MA 100 to MA 125; Mode-LS: MA 125 to MA 130 (Mode S Beacon only); Mode-S : MA 130 to MA 135; Mode-BS : MA 135 to MA 140; Mode-B : MA 140 to MA 256; Omnis: MA 220 to MA 040

The current attitude is: BLON = 179.4 and BLAT = -4.1 for 25 Jun 90. Cross mode B and S QSOs are possible during MA 135 to 140.

AMSAT-OSCAR 10's Mode-B Transponder Now Available for Use

AMSAT-OSCAR-10 appears to be receiving sufficient solar panel illumination to support Mode-B transponder operations, therefore, the transponder is available for general use. Please DO NOT use the transponder if the signals are FMing.

The current estimate of AMSAT-OSCAR 10's attitude is LON 24 deg LAT -9 deg. [AMSAT-OSCAR 10 update received from Graham Ratcliff, VK5AGR, via AMSAT-OSCAR 13 beacons.]

PHASE 3A Remembered

May 23, 1990 marked the tenth anniversary of the death of an OSCAR — an OSCAR which had all the potential of being a great satellite. On May 23, 1980 Phase 3A sat atop the Ariane launch vehicle known as LO-2, attached sideways to the huge Max Planck Institute's Firewheel experiment. On that day optimism was running high at the European Space Agency's Kourou, Fr. Guiana, launch center because of a previous launch success, and there was no reason to think that LO-2 would be different. A number of the AMSAT team members had assembled at the the AMSAT Laboratory at the Goddard Space Flight Center (GSFC). AMSAT's then President, Tom Clark, W3IWI, gave the "play-by-play-action" via a 2 meter link to the GSFC amateur radio club station, WA3NAN. WA3NAN relayed Tom's voice to radio amateurs around the world on the AMSAT Launch Information Net/Service (ALINS).

The launch window opened at 11:30 UTC; because of intermittent rain showers and minor equipment malfunctions "holds" were common during the first hours of the launch window. Jan King, W3GEY requested and obtained several telemetry readings of the battery voltage, worrying about babysitting his progeny right through the launch window. Finally, with seconds to go before the launch window closed, the LO-2 vehicle lifted off at 14:29:40 UTC. At 14:32:57 UTC French controllers were heard saying things like: "non nominal flying...problem in one engine...the rocket is going down...Kourou radar still tracking" and finally, word "splashdown" was heard. Jan, holding back tears, summed it up shortly after the launch failure when he said that "the (radio amateur) community will never know what they lost today."

Jan, Tom, and many of the volunteers who had helped build Phase 3A listened with great sadness as they realized that the focus of many thousands of hours of effort (Jan estimated 30 man years!) was now sitting at the bottom of the Atlantic. Jan recently related the events of that day to WDØHHU saying that upon realizing what had happened he flung a very large book across the room and shouted something appropriate at the top of his lungs. Now, however, he says he doesn't recall what he said — it is all a "blur."

According to Tom, "the gloom, despair, and depression lasted for about a day" when Jan and Karl Mienzer (DJ4ZC) were heard saying "Darn it! We worked too hard to quit now. Let's try again. Lighting can't strike twice." Recovering quickly from this disaster, AMSAT volunteers realized they still had the knowledge and know-how to build another OSCAR satellite. At that point Tom wrote to all AMSAT members requesting their moral and financial support in order to start Phase 3B. The response was immediate, over $30,000 was raised in a few months to start the construction of Phase 3B. This unequivocal show of support proved that radio amateurs from around the world wanted to see the AMSAT OSCAR satellite

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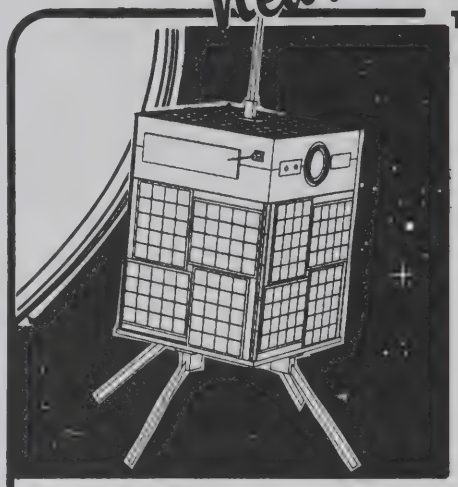

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program continue. Phase 3B became AMSAT-OSCAR 10, later, Phase 3C became AMSAT-OSCAR 13, and AMSAT-DL recently hosted a kick-off meeting for Phase 3D.

For further information about that "black Friday" see Ariane Launch Vehicle malfunctions, Phase IIIA Spacecraft Lost!, Tom Clark, W3IWI, and Joe Kasser, G3ZCZ, *Orbit Magazine*, Volume 1, Number 2, June/July 1980.

5th Annual Satellite Colloquium at University of Surrey, July 26-29 1990

AMSAT-UK is sponsoring a symposium dealing with all OSCAR satellites and digital communications. With the recent launch of the MicroSats , UoSAT-OSCARS 14 and 15, and Fuji-OSCAR 20, Amateur Satellite enthusiasts should find this year's meeting particularly interesting. Question & Answer sessions with various Amateur Satellite and Packet experts are planned as are tours of the UoSat command station. As in years past, the University of Surrey will be the meeting place for this colloquium. The following are the themes for each day:

Thursday July 26th:
International Satellite Day
Friday July 27th:
Introductory Satellite Sessions
Saturday July 28th:
Advanced Satellite Sessions/Packet
Sunday July 29th:
Advanced Satellite Sessions/Packet

If you are interested in finding out more details concerning accommodations and the programs to be presented, contact:Ron Broadbent, G3AAJ, 94 Herongate Road, Wanstead Park, London E12 5EQ England. Tel: 081-989-6741. Fax: 081-989-3430 (24 Hours)

Information is also available on the DRIG BBS and the Hamnet Forum of Compuserve in Data Library 5. The file name is UKCOLL.TXT. It is in MSDOS text format. A file in Wordperfect 5.0 format, named UKCOLL.WP5, is also available in the same data library on Compuserve.

Note that the area code for AMSAT-UK has changed. To use AT&T in the United States to call AMSAT-UK replace the 081 prefix with 011-44-81. Contact your long distance carrier for their international dialing instructions. *Ron Broadbent, G3AAJ and Eric Cottrell, WB1HBU*

WEBERSAT-OSCAR 18 CCD Camera Iris Settings Experiments

For the past several weeks WEBERSAT-OSCAR-18 has been sending three to four pictures daily from outer-space. This continuous stream of imaging data has been part of an on going experiment by the students at Weber State University (WSU) to characterize the amount of natural light which enters the CCD camera for the various iris settings. The goal of this experiment is to find the proper settings for the camera iris for a particular light level. This will help considerably in improving the overall picture quality. With the integration of the on-board earth's sensors in the current software, the occurrence of over exposed pictures or totally dark pictures taken when WEBERSAT-OSCAR-18 isn't earth pointing is no longer a problem. Chris Williams, WA3PSD says that the painstaking task of manually setting the iris from the ground and observing the results will help software engineers in the future as they continue to understand the CCD camera operation. "The early days of random picture taking are gone,"

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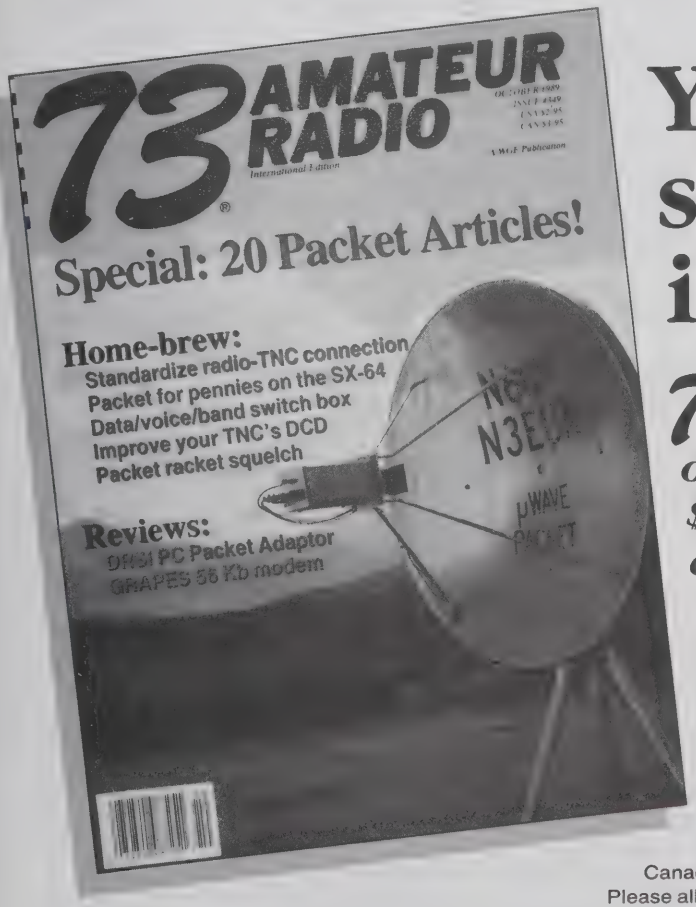

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according to WA3PSD. There are 256 possible settings to which ground controllers can command the camera iris to assume; a "zero" setting has the iris completely closed, a "255" setting has it wide open. What will ultimately come out of this experiment is a look-up table in WEBERSAT-OSCAR-18's software which will say "for a particular light level, use a particular iris setting."

For those wishing to take part in this experiment, WeberWare 1.0 is currently available from the AMSAT Software Exchange. Contact the Exchange at (301) 589-6062 for further information.

Most Asked Questions About WeberWare 1.0

WeberWare 1.0 is a software program for IBM PCs and clones which will take raw packets as transmitted from WEBERSAT-OSCAR-18 and turn them into pictures on EGA/VGA CRT screens. Recently, as more amateurs started to use WeberWare 1.0, the following questions are being asked of AMSAT Area Coordinators about its use:

"Does the TNC [automatically] go into KISS Mode?"

The answer to this no. You must command your TNC into KISS mode by typing: KISS ON. After this, the TNC must be RESTARTed or turned off and back on so that it will actually start to operate in KISS mode.

"How do you store the files?

As ASCII. The picture data from WO-18 comes down as raw binary data, that is, it is not displayable as ASCII characters. As the data is received, your communications program must store the binary packets in a file. Do not be concerned about ASCII telemetry frames which occasionally come down along with the binary packets. WeberWare 1.0 ignores the ASCII telemetry.

"How do you upload a picture to WeberWare 1.0?"

When you store the data from a WEBERSAT-OSCAR-18 pass, name the file so that its file extension is ".RAW" and put the file in the same directory in which WeberWare 1.0 resides. After you have invoked WeberWare 1.0 and the main menu comes up, you will see an option for "PACKETS TO PIXELS." Upon choosing that option, WeberWare will give you a menu/choice of all files that have file extensions ".RAW"

WA3PSD of WSU points out that a complete picture file will take up about 156 Kbytes in a disk file. According to him one can quickly start to run out of hard disk space in a HURRY!

Project OSCAR Seminar September 29 & 30, 1990

Everyone interested in Amateur Radio satellites is invited to attend a seminar during the last weekend of Sept. There is so much information available, and so many subjects will be covered that an entire weekend will be devoted to OSCAR! Speakers will cover all aspects of OSCAR from basic information necessary to get started, right up to advanced topics for the experienced OSCAR user. Computers will be available to demonstrate OSCAR software. Displays showing some of the equipment used by OSCAR users will also be available. Whether you are interested in RS satellites on 10 meters, worldwide DX available on OSCAR-13, telemetry sent from DOVE and other Microsats, or you just have many questions about OSCAR, this seminar is a must for you to attend.

A partial list of subjects that will be covered include the following: Understanding Keplerian Elements; How to Operate Microsats and Fuji OSCAR 20 Successfully; OSCAR - a Basic Tutorial About Using the Satellite; How to Use the RS Satellites; Present Status and Future Plans for OSCAR; Preamplifiers and How To Use Them Properly; Successful Mode L Operating; An Open Forum Question and Answer Session; Successful Omni Antennas for Microsats; and How Noise Figure Relates to Successful OSCAR Operation.

The following topics may be added pending a speaker: Understanding OSCAR Telemetry; Successful Mode S Operations; and an AMSAT-NA Forum.

Preregistration is required so that adequate seating and supplies will be available. The funds raised will cover the minimal expenses to hold the seminar, and all excess money raised will be allocated towards the building of future Amateur Radio satellites. Here is the best opportunity to ask all the questions you ever had about any OSCAR!

The seminar will be held at a convenient location right off highway 280 in Cupertino. Motels, restaurants, and shopping are all close by. On Saturday evening, there will be adequate time for informal discussions with those you want to learn more information from.

Sponsors of the seminar: The Tandem Radio Amateur Club, Project OSCAR, Inc.

Registration fee for the seminar will be $15.00 per person. This includes a copy of the papers published for the seminar. For complete registration forms and details of the seminar, send a business size, self-addressed, stamped envelope (SASE) to: OSCAR Seminar, Project OSCAR, P. O. Box 1136, Los Altos, CA 94023-1136.

Telemetry Standard

(from page 20)

with this or a similar format, the following advantages accrue:-

Spacecraft developers can put what they want into the binary data area.

Ground system software developers will know where to look for different information, and can write software that is really table driven.

Whole Orbit data can be put into the same format. We can use long packet lengths in future, and currently with the 256 byte limit, use the segment identifier to know which part of frame is in the packet. With this approach the 2 frames of DOVE ASCII TLM would have been segments 1 and 2.

A whole WEBER picture could be considered as one frame in many segments. The picture number could be the first two bytes of the data part after the secondary header.

The DOVE or Fuji-OSCAR 20, 'all ASCII telemetry' could be dropped into the 'binary' area without change, if it is desired to keep it in ASCII. However with a published standard, there should be no need. Also binary bursts could be interspersed with voice data, and would minimize QRM, yet provide an impetus to get a decoder/displayer working.

Ground station software would only have to be updated if new data types are defined.

Groundstation software could process multi-byte telemetry from different packets after checking that the timeframe in two or more segments is the same.

The Ground Segment

The ground station software that decodes and displays the received

(Continued on page 26)

Table 3 — Typical entries in a Groundstation Software Look-up Table

```
00,9,Rx A/B Audio(W):,+0.000,+0.0246,0.000,V(p-p),2,11,1,6,1,0,0,0
01,9,Rx E/F Audio(N):,+0.000,+0.0246,0.000,V(p-p),2,11,32,6,1,0,0,0
02,5,PSK TX, 2,12,1,8, FM TX, 2,13,1,8, WDG TX, 2,14,1,8, BAT A,
   2,14,1,8, BAT B, 2,16,1,8, HI PWR A, 2,15,1,8, TX A, 0,17,1,8,
   TX B, 0,17,10,18
03,9,Tx B Power:,+0.000,+0.0246,0.000,V(p-p),2,11,1,6,1,0,0,0
```

Dear Joe...

This space is reserved for your comments.

The Better 'Gater Getter?

With the growing interest in satellite communications, the need for reasonable transponder solutions become even more important. As interest grows, the number of unintentional and intentional abuses grow also. The bottom line is increased transponder abuse.

Also part of the bottom line is the limited power available to the transponder to begin with. This is nothing new to satellite veterans, but may surprise some newcomers. The problem then, is that as inexperienced users use too much uplink power, they rob power from all other users on that transponder. Some of the other users then might also increase power, further increasing the problem.

A transponder is basically a mixing process that takes one passband and produces the same signals on a different band. A converter of sorts. For example, Mode A involves taking a portion of two meters and converting the output frequencies to a portion of the ten meter band.

The mixer does not play favorites in this process. In your receiver, stronger signals arrive at the IF stages, with more strength than the weaker ones. A transponder functions the same way.

It has been suggested that a geostationary satellite would likely include a tunable notch filter under control of the onboard computer (OBC), or perhaps two or more of them. The computer then plays "seek and destroy" on the 'gaters, notching their signals down to proper levels, so that other users can carry one.

This solution is costly, but necessary. But the biggest problem is the number of 'gaters it can get at one time.

A partial solution might be effective, if the partial solution only annoys the 'gaters. What if the tunable notch filter, with the aid of the OBC notches every 'gater on the passband, but only for a short time? Instead of notching the 'gater as long as he's there, you get the OBC to dwell on the abuser for a portion of a scan cycle.

The "scanning 'gater getter", then has the basic effect of modulating the 'gater's downlink signal, because of its scanning action. If the scan rate is carefully chosen, the generated sidebands should not be too great. Furthermore, the OBC can dwell on some 'gaters more than others. In fact, if there is few or just one 'gater on the band, the notch could be used nearly full time on the offender.

The offender, hears this 300 Hz (or something like it) on his downlink. Anyone else that might normally QSO with the "big gun", will now find it too annoying. Furthermore, it serves as an immediate "You're using too much power dummy!" reminder to the unintentional offender. As the offender backs off his power, the tone will diminish with strength.

This scanning approach still has engineering challenges. One problem will be the power supply. As the notch tunes in and out of a 'gaters signal, the power load will rise and fall. Unchecked, this could modulate all users' downlinks to some extent.

Another problem is 'gater sideband generation. Scanning frequency plays a

(Continued on page 30)

AMATEUR TELEVISION

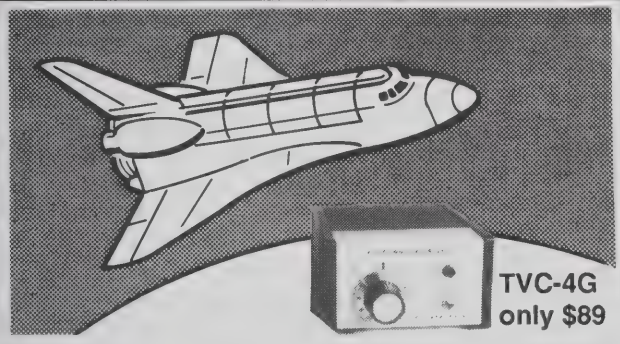

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Figure 1 — Typical Binary Telemetry Packets

```
DOVE-1>TLM:
1^&900531212@!@!*!*!*!*!*!**$%%^%&*()&^*%$%^*@$!!

DOVE-1>TLM:
2^&900531212@!@!*!*!*!*!*!**$%%^%&*()&^*%$%^*@$!!
```

Data would be stored on disk without the AX.25 packet headers.
My ground station software would store the two packets as,

```
DOVE-1   1^&900531212@
!@!*!*!*!*!*!**$%%^%&
*()&^*%$%^*@$!!W3/G3Z
CZ  DOVE-1   2^&900531
212@!@!*!*!*!*!*!**$%
%^%&*()&^*%$%^*@$!!W3
/G3ZCZ   .
```

My ground station could also store it as:

```
DOVE-1   0^&900531212@
!@!*!*!*!*!*!**$%%^%&
*()&^*%$%^*@$!!@!@!*!
*!*!*!*!**$%%^%&*()&^
*%$%^*@$!!W3/G3ZCZ   .
```

after reconstituting the single frame.

telemetry would add the spacecraft identification and the callsign of the ground station into two 10 byte data fields before storing the data without the packet header information to disk (the spacecraft identification at the start, the ground station call at the end of the data). The AMSAT archive would then know who captured what and when. The ground station could also reassemble all the segments into one long block of data on disk, or keep them segmented, or do both depending on whether it got all the packets in a frame or only some of them.

To display and process the data, the ground station software would have entries in the look-up tables associated with the type of data in each telemetry channel and what the software is expected to do with the data in that channel when received. Each data type would be arbitrarily assigned a type number or other identification by each programmer. A section of a typical look-up table in the ground station software is shown in Table 3. In this example, a Type 5 channel is an 8 bit digital status and a Type 9 channel is a quadratic channel just like the MicroSats use today. Typically the contents of each row would be identified as follows:-

For each Type 9 (8 bit quadratic telemetry parameter:

channel number (2 bytes, e.g. '0F')
Type of telemetry (e.g. byte, 8 bit quadratic) Description text string (e.g. '+Z Array Temp.')
Quadratic Equation Coefficient C
Quadratic Equation Coefficient B
Quadratic Equation Coefficient A
Units text string (e.g. '.C')
Display page number
Display page row
Display page column
Display width for Engineering Units
Number of digits after the decimal point
Limit check flag (0 = do nothing, 1 = check below low limit,2= check above high limit, 3 = check for [below low limit] or [above high limit])
Low limit value (e.g. -4.00)
High limit value (e.g. +10.6)

For each Type 5 telemetry parameter
channel number (2 bytes, e.g. '0F')
Type of telemetry (e.g. byte, 8 bit quadratic)
Bit 1 text string (e.g. 'PSK TX')
Bit 1 Display page number
Bit 1 Display page row
Bit 1 Display page column
Bit 1 Display width

These five lines would be repeated for each of the 8 bits in the byte until the last bit.

Bit 8 text string (e.g. 'PSK TX')
Bit 8 Display page number
Bit 8 Display page row
Bit 8 Display page column
Bit 8 Display width

Archiving would be easy, identifying by spacecraft, time, and ground station would be easy. The data files would be system independent, could be mixed together by spacecraft or by date and in the future could even be published on a CD-ROM.

Use of the Standard

Once a standard format is agreed to, people will once again develop software for ground station use. Typical software can easily provide the following capabilities:

* Real time and Playback modes.
* Automatic Capture-to-disk of raw telemetry.
* Extracts predetermined telemetry channel data to a database or spreadsheet readable file for further analysis.
* Link quality measurement.
* Capability to print the raw telemetry as it is received.
* User configurable display pages (screens). You set the position on the page (width of engineering unit field, and number of decimal places) that a parameter is displayed at.
* Wild card page (parameter shows up on all pages).
* Selectable display of Engineering units or Hex byte for each display page.
* Display of raw packets.
* Color changes if a parameter value changed between successive frames.
* Audio and visual alarms if a telemetry value exceeds, falls below or falls outside a preset limit value(s).
* Dumb split screen terminal mode.
* Customizable colors, PC to TNC baud rate, data parity and stop bits.
* Display of channel trend, e.g. that the last value was greater/less than the previous value for that channel.
* Default spacecraft configuration files.
* Time of day clock display (in HH:MM:SS format).
* Display of Spacecraft Elements (in AMSAT Format).
* Automatic update of spacecraft element set from disk file.
* Display of Time to Spacecraft AOS (in HH:MM:SS format).
* Automatic tuning of radio to different frequencies depending on scheduled AOS, and subsequent selection of applicable spacecraft configuration file.
* Scanning radio frequencies during non-pass times for terrestrial data capture, potential antipodal reception or meteor scatter use.

Summary

A telemetry standard such as the one proposed in this article would tend to allow the development and use of smart user friendly groundstation software in real time as well as for later data analysis. Students will be attracted to science and engineering once more as well as amateur radio in general and AMSAT in particular. How about it, what do you think?

An Alternate Approach For "Precise" Doppler Shift Determination

By M. W. "Maury" McMahan, K4GMJ
253 Providence Square
Greenville, SC 29615

Introduction

"Getting on Frequency" on the OSCAR satellites requires knowing meaningful Doppler shift[1] based on the calibration of the specific receiver and transmitter in use.

My previous article described the original simplified procedure for determining Doppler and then how to quickly determine the exact uplink frequency for any given downlink without causing QRM.[2]

This article describes an alternate system for determining Doppler for those operators that adopt the "Getting on Frequency" procedure.

Alternate Doppler Determining System: Background

While demonstrating and discussing "Getting on Frequency" with my son Kevin McMahan, a mechanical engineer, he said, "Why don't you determine the uplink-downlink radio frequencies for Doppler calculations by transmitting an audio tone (on LSB) and comparing the same audio tone (zero beat) with the tone downlink received on the downlink."

This idea sparked my curiosity, and I decided to run a test to determine the feasibility, usability and/or practicability of the idea.

For the test I used a set of stereo earphones. I hooked the R.H. earphone to an audio tone generator that also fed into the 435 MHz mike input. Then I connected the L.H. earphone to the 2M downlink receiver.

Next I selected a clear spot within the AMSAT-OSCAR-13 transponder and uplinked the audio tone (while listening to it in the R.H. earphone). I then adjusted the 435 MHz frequency up and down a couple of kHz and found the transmitter frequency that provided an audible tone in the downlink L.H. earphone. Then I fine tuned the transmitter frequency until the audio tone in the R.H. and L.H. earphones matched (Zero Beat). As a double check I plugged in the monaural earphones, gave my call on the uplink and heard my return signal "right on" normal voice tones.

This test proved the principle and gave me an alternate method to obtain precise uplink-downlink frequencies for Doppler determination.

Secrets for Success

The audio tone must be transmitted on LSB. A CW or keyer doesn't work for obvious reasons.

The audio tone must be in the 300 to 3000 Hz range.

I would expect that, depending on your ears, one part of this frequency range may be easier to zero beat than others.

A single tone is required. For example, a touch tone pad produces dual tones when just one button is pushed whereas by pressing two buttons simultaneously a single tone is produced and is very usable.

The "Doppler Box"

Figure 1 shows a line diagram of the Doppler determining system including the "Doppler Box".

With this arrangement you can readily switch from "Doppler check" to "Normal" operation without changing earphones and/or rearranging the mike and earphone plugs.

I strongly recommend the use of a momentary push button switch for the transmitter keying line to avert the possibility of leaving the transmitter keyed longer than required (normally 4 to 5 seconds).

(Continued on page 30)

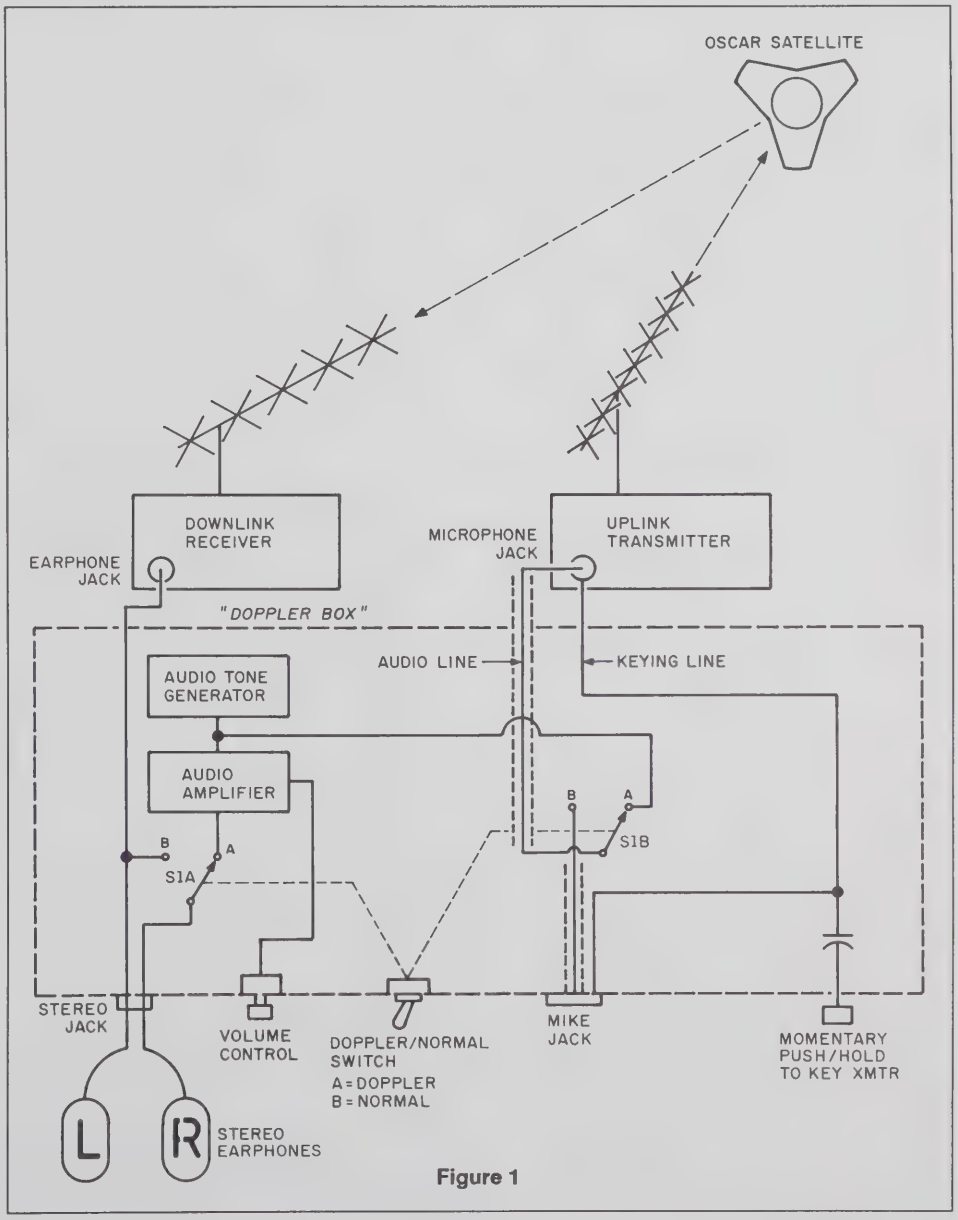


Figure 1

Epitaph for UoSAT-OSCAR 9

By Pat Gowen, G3IOR @ GB7LDI
17 Heath Crescent
Hellesdon, Norwich,
Norfolk, NR6 6XD England

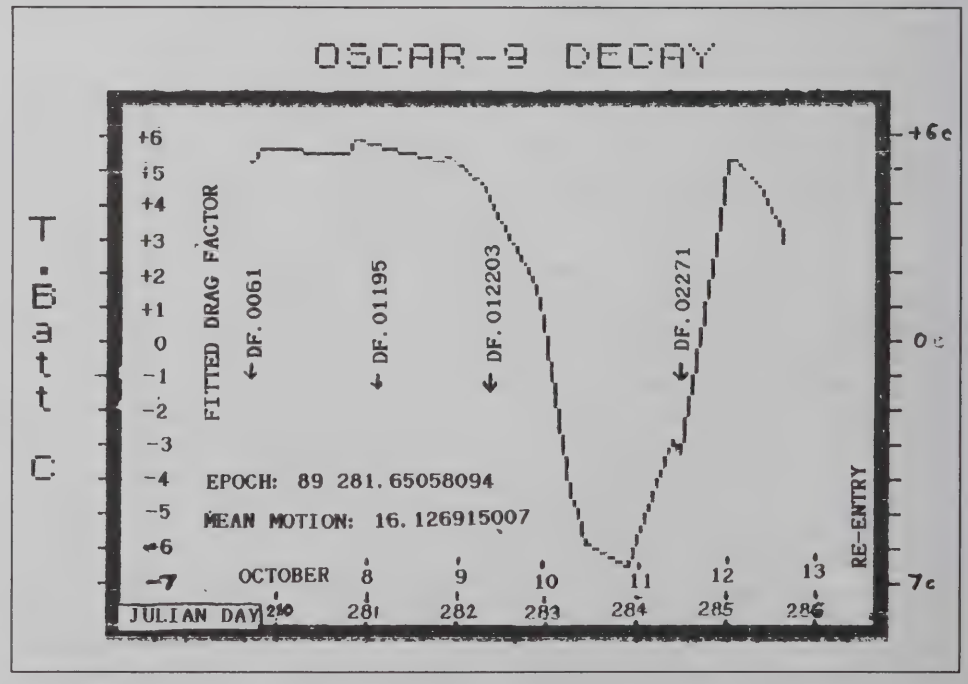
After having been functioning in space for over eight years despite its modest three-year design lifetime, UoSAT-OSCAR 9, alias UoSAT-1, fell to Earth in early October 1989. UoSAT-OSCAR 9 had been launched from Vandenburgh Air Force Base in California at 1127 UTC on 6 October 1981 into a 554 km, 95 minute, polar sun-synchronous circular orbit. UoSAT-OSCAR 9's mission was not without its problems for in April 1982, a software error resulted in both the 435.025 MHz and 145.825 MHz beacons being commanded "on" simultaneously. The net result was that as one or other of these bands was needed to uplink commands to turn either of the beacons "off", the desensitizing of both command receivers at the same time rendered commanding impossible.

The impasse was finally broken on 20 September 1982, when the 145.025 MHz beacon was finally silenced by beaming up a 12 Megawatt (this being even more than some AMSAT-OSCAR 13 users employ!) command signal, so permitting faultless and highly informative operation for the next seven years. Although criticism of the lack of a transponder was at first indicated by a minority of Radio Amateurs, the decision to create a scientific satellite proved correct, as the degree of assistance rendered to scientific and educational institutions improved the recognition of the useful aspects of Amateur Radio, as well as undoubtedly preserving some of our jealously regarded frequencies. Much has been written on UoSAT-OSCAR 9 findings in the non-Amateur field of publications, so enhancing the possibility of future similar payloads.

Even in the week prior to its demise, UoSAT-OSCAR 9 continued to transmit valuable telemetry, which provided insight into satellite reentry conditions. This is the first known time that any satellite has continuously provided all (60) parameters of data to the point of terminal decay. (ISKRA's 2 and 3 were intermittent, launched at SALYUT 7 altitude, and had limited telemetry.) By using the element set based on an epoch of day 281.65058094 (08 October 1989, 1536:50), giving a mean motion of 16,12691500 orbits per day, and adjusting the increasing decay rate to precisely match measured AOS, TCA and LOS, accurate tracking and orbital heights were determined, thus permitting a relationship to the solar flux elevated drag factor to be identified.

On October 6 the drag relative to the Keplerian element set was found to be 0.0061, two days later the value had to be increased to 0.01195, the following day to 0.012203, and when last heard at 2202 UTC on 12 October, it had climbed to 0.02271. A study of the recalulated mean motion, giving the anomalistic period, and the mean height, permitted calculation of the rate of descent and the satellite position relative to the various high solar flux compressed identified ionized layers. It further permitted inspection of the passage of the satellite in solar charging conditions or in discharging eclipse, so giving an indication of any I^2 heating effects in the onboard battery.

The variable effects of frictional heating could be observed from a study of the battery temperature transmitted on channel 08 and the current charge/discharge heating effect was considered negligible. The mass of the battery was considered to provide a good smoothing effect to other parameter temperature variations, little hindered by the effects of toppling, tumbling or darkside/lightside variables. It was advantageous that this parameter was transmitted as the eighth of the first ten channels transmitted by CW on the 14.0013, 21.0018 and 29.510 MHz HF beacons. Beacons signals on the two lowest frequencies were frequently heard in daylight at times when UoSAT-OSCAR 9 was well sub-horizon. This permitted regular readings at many parts of the orbit around the Earth well beyond the range limits of the 145.825 MHz telemetry. The temperature variation was strangely not the expected "close to exponential" curve. As the spacecraft came into the discontinuity 'F2' layer, the temperature climbed from just below zero to some 6 degrees Celsius. On 10 October it was +1, and the following day down to -6.3. It then went up again as it may have gone through the main F1 belt, peaking +5.8C on the morning passes of 12 October, but dropped down to +4 by that evening. The findings, AOS, TCA, LOS, Doppler curves were compared by many listeners in the UK on a 3.780 MHz post pass net each day prior to the re-entry. As far as is yet known, the 2201 UTC 12 October telemetry was the last recorded from the UK, although it was heard from 0343 to 0349 UTC on 13 October by K9CIS who reported "...telemetry nominal...".



The graph shows channel 08 battery temperature variations plotted on the Y axis and the October day date and Julian Day time on the X axis. Inset is the point of insertion of the discovered new drag factor (acceleration) needed to be applied to permit accurate tracking against the epoch and mean motion given. All theories on findings would be very welcome!

ZRO TEST UPDATE

By Andy MacAllister, WA5ZIB
14714 Knightsway Drive,
Houston, TX 77083

The K2ZRO Memorial Station Engineering Award program was begun five years ago via AMSAT-OSCAR 10 to promote operating skill and receiver performance via Phase 3 satellites. Since the corruption of the memory chips on AMSAT-OSCAR 10 the on-going contest has shifted operation to AMSAT-OSCAR 13.

The exercise does not measure how much power a station can generate. The purpose is to test the listening capabilities of individuals monitoring the transmissions of a control station sending numeric code groups at ten words per minute using gradually reduced power levels starting at a level equal to that of the general beacon, level Z0. The next level, Z1, is sent with a transmit power three dB down (half power). Transmissions continue level Z9, a point 27 dB below the beacon. During a typical test the power output at the control station is usually in the tens of milli-Watts at level Z9. Very few stations have been able to hear these incredibly weak signals, and even fewer have accurately copied the code groups. Those that have are on the "ZRO Test Honor Roll" and are eligible for a special "Z9 Club" certificate.

From January, 1989, through January, 1990, 21 sessions via Modes "B" (two-meter downlink) and "JL" (70-cm downlink) were run. Dates and times were chosen for convenient operation and favorable squint angles. Cliff W6HDO was responsible for "JL" sessions from Morro Bay, California and Andy WA5ZIB sent the "B" tests from Houston, Texas. Reports were received from stations in Asia, South America, North America and Europe. Table 1 shows the lower level (starting at level Z4) results of the AMSAT-OSCAR 13 runs for that one-year period.

The basic ZRO Test certificate is red and blue on beige parchment and can be obtained by anyone able to copy the level Z0 numbers on either Mode "B" or "JL". Endorsement stickers for the levels through Z8 are silver for Mode "B" and gold for Mode "JL". The cost of the award is $3.50 for AMSAT members and $5.00 for non-members. The fee covers first class mailing of the certificate, printing costs and all future endorsements, including the "Z9 Club" certificate. International participants are encouraged to submit extra funds to cover air-mail postage of the certificate in a crush-resistant box. For those who would like to know how well they did but may not be interested in a certificate, a report will be sent to anyone submitting numbers copied to WA5ZIB. Return postage is not necessary, but it is appreciated. Reception reports must be submitted within 120 days of a test to go in the record book. After that time the number groups are published. Numbers for the test period from January 14, 1989 through March 5, 1989 were published in *AMSAT Satellite Report* Number 192 dated December 15, 1989. Numbers for the period July 1989 to January 1990 are shown in Table 2.

Don't wait till you have the "perfect" receive system to participate in the ZRO Tests. It is better to start listening and reporting with current equipment and then make appropriate modifications to antennas, preamps and receivers, and then checking the results of the station changes on subsequent ZRO Tests. Some participants have even listened with portable systems and mobile equipment. Henk, PAØHTR, used a small Yagi propped on overturned buckets in a boat to copy Mode "B" tests on two meters, with excellent results. Attention to detail and perseverance may put you on the ZRO Honor Roll, or at least pinpoint station deficiencies for later upgrades. More tests will be scheduled for the Fall. They will be announced via the AMSAT HF and AMSAT-OSCAR 13 Operations Nets. The schedules will also be available via packet bulletins. ZRO Test brochures describing test procedures and some historical background are available for a self-addressed-stamped envelope with two units of postage from Andy MacAllister, WA5ZIB, AMSAT V.P., User Services. Good Luck!

Table 1 — AMSAT ZRO Test Honor Roll
January 1989 to January 1990

Mode B - Z4
AJ9U, DD1US/A, DG9MAQ, DL1IU, PAØHOP, K5EVI, KA2DWV, KB3ML, W3GYK, WB2EMS, WI6D.

Mode B - Z5
Frank Hahnel, Birger Lindholm, Mavropoulos Yean, DB7OB, DD1PI, DJ2OQ, DK1KC, DL3GAX, DL3OAG, JR8XPV, KØJAN, K7JRA, KA9LNV, KF7KN, KO9Q, N3FKV, N8AM, NW2T, PA3BLY, VE6GK, W2GFF, W4FCJ, W4KSV, W5VGF, WA3PGQ, WA4ZZU, WA7TSD.

Mode B - Z6
AA6NP, AE3T, DB4UF, DC6EV, DC7IB, DG3DBI, DG4NAX, DG8NAB, DJ9ME, DK1KQ, DL3SBP, G3AUB, G4XXW, KØGCJ, K2MPE, K2VPR, K4ZQX, K6PGT, K9MWM, KA9CLP, KD6WG, KE7WR, N4MEY, N8DNX, N9HR, PAØHTR, PBØAIO, VK5AGR, WØBPP, WØRUE, W2WD, W3VVP, W6ISO, W6SHP, W7UAB, W9MBL, WAØRGV, WB1BRE, WDØE.

Mode B - Z7
AJ9P, DF6LO, DKØUB, DK2LM, DL1TV, DL1YDD, DJ1YQ, DL6DBN, DL9BBL, DL6KG, DL6LAU, DL9CI, G5TU, KA5SMA, KA8ZLA, LU1HGN, LU1HUC, NM3A, PE1KDO, SMØKV, SM1BUO, SM5BVF, KØBEJ, KB5MU, KE7NR, KF4AU, KG5OA, WØWGZ, WØZZQ, W2APU, W2HG, W6HDO, W6SZ, WA2FHL, WA6ARG, WA7DEO, WB9ANQ, WD8QCN, WA5QGD, WD4O.

Mode B - Z8
Bill Hall, AA5BY, AA6OJ, DF5DP, DL1CF, G3RUH, HB9FD, K2RDX, K8XF, KA1M, KA5DNP, KB8S, KG4TM, KJ7F, NØERC, N5BF, N5FD, N5UD, N8AI, N9EP, NF6S, NJ1H, NU9H, OH5LK, VE6VM, WØCL, WØDEN, WØSL, W1NU, W3KH, W4MFZ, W4MLA, W4RDI, W5AL, W5BKK, W5GEL, W6SYA, W7KRC, W8JLE, W8ZD, W9JI, WA4GSS, WA5NOM, WB6GFJ, WB6LLO, WB8LBC, WB9EOP, ZL1TRE.

Mode B - Z9
DLØWH/DF7IT, DL5DAA, K9NO, KCØTO, N8DUY, PA2CHR, PA3EON, SM1MUU, W7ID, W7KIV.

Mode JL - Z4
AE3T, F9FT, DB4UF, DK2LM, DL5BBL, KB5MU, KE7NR, SM1BUO, WØRUE, W5GEL, WA5TWT.

Mode JL - Z5
Birger Lindholm, AA6NP, AA6OJ, DKØUB, DL1CF, DL1YDD, DL6DBN, DL6KG, DL9CI, KØJAN, K9MWM, KG5OA, N8AM, W1NU, WAØRGV, WB9OEP, WD4O.

Mode JL - Z6
DK1KQ, KG4TM, KD6WG, N3FKV, N8DNX, N8DUY, SM5BVF, VE7CLD, W6ISO.

Mode JL - Z7
AJ9P, DJ9PC, DL5DAA, HB9FD, K2RDX, N5BF, W6SYA.

Mode JL - Z8
G3IOR

Mode JL - Z9
DF5DP, W7ID

Table 2: Transmitted ZRO Test code groups from 01JUL89 through 20JAN90.

Date/Mode	00000	11111	22222	33333	44444	55555	66666	77777	88888	99999
01JUL89/B	38912	67654	20155	92813	47650	31328	71549	03284	13973	28457
08JUL89/B	57942	03867	39115	65291	76745	80652	97218	23807	16825	76504
16JUL89/B	95352	87531	67342	59430	68137	32852	41397	28512	60389	74851
22JUL89/B	23145	67630	89281	43145	51957	16804	35712	46083	50986	13627
29JUL89/B	97420	86121	77682	03216	57695	93284	85163	29304	65472	16293
12AUG89/B	63549	13872	50464	38914	97625	76013	89352	26789	18294	64057
12AUG89/L	12345	62573	31056	62437	44321	63021	82831	92934	54420	71434
25NOV89/B	97214	86322	65438	90613	27618	36724	89275	10637	46570	61925
02DEC89/L	12345	65789	27934	46572	34890	41293	46732	98040	36993	77821
02DEC89/B	87259	63102	36447	91056	78214	46892	80752	26135	70238	17293
16DEC89/L	12345	73103	34721	89075	54720	05561	37890	23473	89012	38541
16DEC89/B	15432	67630	81063	27938	60709	19275	96310	58942	24327	68364
30DEC89/B	31415	98620	77093	51764	08315	82694	37826	16395	92871	49502
06JAN90/L	12345	79023	38691	13972	26733	59380	33771	89321	73702	28930
13JAN90/B	41325	67323	75821	65998	14705	90732	49261	83092	50164	78326
20JAN90/B	62913	76801	10609	77584	87352	94380	23917	54389	31725	45128

Doppler Shift Determination

(Continued from page 27)

Variations of the "Doppler Box"

For those who prefer a more sophisticated readout system, a frequency comparator circuit feeding a zero center null meter; a series of LED's; or a "Light Bar" could be used. I'll leave the ingenuity of the reader to come up with their preference.

Getting on Frequency

The "Doppler Box" is intended to be used only for determining an uplink-downlink frequency so that Doppler can be calculated using the simplified formula and calculating procedure previously explained.[2]

With known Doppler you can quickly calculate uplink frequency for any downlink.

For the Doppler determining procedure to be non-obtrusive, operators should always select a portion of the band that is clear of other operators to minimize the possibility of QRM.

In conclusion I hope that you enjoy QSYing around the band using this approach.

Notes

1. "Meaningful Doppler Shift" as used in this article is a number that combines the affect of real Doppler Shift and the calibration errors present in the specific transmitter and receiver in use. It's a practical usable number because these calibration errors are factored in.

2. "Getting on Frequency with Precision and Without QRMing Others on OSCAR-13" by M. W. "Maury" McMahan, K4GMJ. *The AMSAT Journal*, Aug. 1989, page 5.

Lindenblad Antennas

(Continued from page 6)

plane antenna constructed from number 10 wire soldered directly to a chassis mount "N" connector[3] appears to work as well as my 2 meter beam most of the time. When conditions are good I only need the full 100 watts to the ground plane when the spacecraft are near the horizon. When they are above 20 degrees I often get good throughput with only 20 watts. If I suddenly stop getting my "UI" frames digipeated, increasing the power back up to 100 watts usually helps. If I still do not get good throughput, increasing power to my maximum of 160 watts rarely helps. I suspect the few times it did, I was just overpowering contending stations on the same uplink channel. The other times when 100 watts did not help, may have been due to geomagnetic disturbances, or, perhaps the satellite's uplink antenna was temporarily behind the satellite, as acceptable throughput usually returned in a minute or two. Maybe circular polarization could have helped. I also have noted poorer throughput to the south, while a San Diego station reported poorer throughput to the north. Obviously these are areas that need more study and experimentation to sort everything out.

As the MicroSat's uplink antennas are linear polarized, circular polarization may not be as important as with the downlink. But knowing how it helps on mode JA when I use my beams, my next area of antenna experimentation will probably be with a pair of Lindenblad uplink antennas. I will also check WWV for a geomagnetic report whenever there is a pass with poor throughput.

Getting on mode JD has not been easy for me. Do not feel you are alone in your frustrations during your first attempts to work the MicroSats. One wrong hardware or software switch often found me baffled for a whole pass as to why I was not getting any "UI" returns. I suggest making a thorough hardware and software check-list once you get it all figured out for your station. It has been a challenging and rewarding project. I have learned a lot and there is yet a lot to learn. This is an open field for the experimenter to study, build and test ideas that can result in significant contributions to the utilization of future of amateur digital satellites.

References

1. *The Satellite Experimenter's Handbook*, pages 6-17 to 6-20. By Martin R. Davidoff, K2UBC. Published by the ARRL and also available from AMSAT.

2. *The Radio Amateur's Handbook*, 1980, pages 14-9 to 14-10. Published by ARRL.

3. *The Radio Amateur's Handbook*, 1986, pages 33-29 to 33-30. Published by ARRL.

4. *Oscar News*, June 1990, page 12, "The JARL News" (from JAMSAT and *Westlink Report*). Published by AMSAT-UK.

Dear Joe

(Continued from page 25)

role, but the dwell time must also be figured in. If there are several 'gaters to get, then the notch dwell time for each will be a small fraction of the entire scan cycle. The general effect of this is to modulate these signals with pulses. Pulse modulation creates more sideband spread. However, if there are enough 'gaters on the passband to bring the problem to this level, then this is perhaps the best that could be hoped for anyhow.

I hope some hams out there will put on their engineering hats and work out the specifics of this possibility. Even better, maybe test the concept. In any case, as we get closer to the prospect of Phase-IV, we need to be continually seeking better solutions than the ones that we have now.

At this point in the crossroads, there are mostly two 'gater types — unintentional abusers, and those who insist on "big gun" downlink strength. However, as we go Phase-IV, the third type, the twisted prankster type, will eventually become an increasing threat. These will be the ones with the technology, but without the maturity and license.

Hope this helps. — *Warren W. Gay, VE3WWG*

Modifications *(from page 20)*

These new additions make tuning a breeze, even from across the room. Simply leave the meter switch in the TUNE position and tune first for CLK and CAR lock, then center the tuning meter. It is immediately evident if the downlink is usable or that the data will be corrupted by spin modulation, fade or other gremlins. A blinking CLK LED is no good at all.

These two projects have been valuable additions to demodulator. My thanks to Jack Mathias W9FMW for encouraging me to get these modifications into print.

G3RUH says AMSAT Australia has a tuning indicator board available for the demodulator, as well as the "P3C" data capture program.[4]

Notes

1. Circuit boards and kits available from: Radio Kit P.O. Box 973 Pelham NH 03076 phone (603) 625-2235

2. Updated component values.

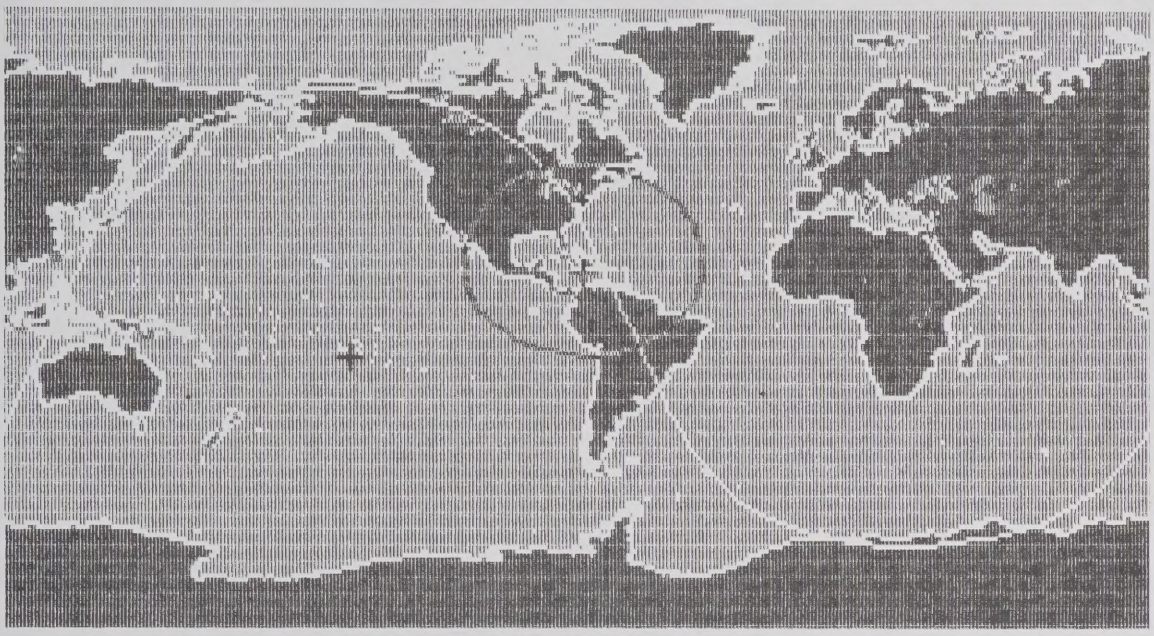
Component	*New value*
R7	330K
R9	150K
R10	470K
R12	330K
R14	330K
R17	100
VR3	50K to 100K Linear taper pot
C10	1 nF 5% polystyrene
C11	47 nF
C12	4.7 nF 5%
C13	47 nF
C16	10 nF

3. Project OSCAR Inc., see p.24, in this issue.

4. AMSAT-Australia, G.P.O. Box 2141, Adelaide 5001, Australia.

Satellite Tracking

with your PC and the Kansas City Tracker & Tuner



The **Kansas City Tracker** is a hardware and software package that connects between your rotor controller and an IBM XT, AT, or clone. It controls your antenna array, letting your PC track any satellite or orbital body. The **Kansas City Tracker** hardware consists of a half-size interface card that plugs into your PC. It can be connected directly to Kenpro 5400A/5600A or Yaesu G5400B/G5600B rotor controllers. It can be connected to other rotor assemblies using our Rotor Interface Option.

The **Kansas City Tuner** Option provides automatic doppler-shift compensation for digital satellite work. The **Tuner** is compatible with most rigs including Yaesu, Kenwood, and ICOM. It controls your radio thru the radio's serial computer port (if present) or through the radio's up/down mic-click interface. The **Kansas City Tuner** Option is perfect for low-orbit digital satellites like the NOAA and Microsat satellites.

The **Kansas City Tracker** and **Tuner** include custom serial interfaces and do not use your computer's valuable COMM ports. The software runs in your PC's "spare time," letting you run other programs at the same time.

The **Kansas City Tracker** and **Tuner** programs are "Terminate-and-Stay-Resident" programs that attach themselves to DOS and disappear. You can run other DOS programs while your antenna tracks its target and your radios are tuned under computer control. This unique feature is especially useful for digital satellite work; a communications program like PROCOMM can be run while the PC aims your antennas and tunes your radios in its spare time. Status pop-up windows allow the user to review and change current and upcoming radio and antenna parameters. The KC Tracker is compatible with DOS 2.00 or higher.

Satellite and EME Work

The **Kansas City Tracker** and **Kansas City Tuner** are fully compatible with N4HY's QUIKTRAK and with Silicon Solution's GRAFTRAK. These programs can be used to load the **Kansas City Tracker's** tables with more than 50 satellite passes.

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Working DX or contests and need three hands? Use the **Kansas City Tracker** pop-up to work your antenna rotor for you. The **Kansas City Tracker** is compatible with all DX logging programs. A special callsign aiming program is included for working nets.

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The **Kansas City Tracker** comes complete with special control programs that allow the packet BBS user or control-op to perform automated antenna aiming over an hour, a day, or a week. Your BBS or packet station can be programmed to automatically solicit mail from remote packet sites.

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The **Kansas City Tracker** has a special morse-code sender section that will announce the rotor position and status automatically or on request. The speed and spacing of the code are adjustable.

The **Kansas City Tracker** and **Tuner** packages include the PC interface card, interface connector, software diskette, and instructions. Each Kansas City unit carries a one year warranty.

- KC Tracker package for the Yaesu/Kenpro 5400A/5600A controller $189
- Interface cable for Yaesu/Kenpro 5400A/5600A ..... $ 19
- Rotor Interface Option (to connect to ANY rotors) ..... $ 30
- KC Tuner Option ..... $ 79
- N4HY QuikTrak software ..... $ 80

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